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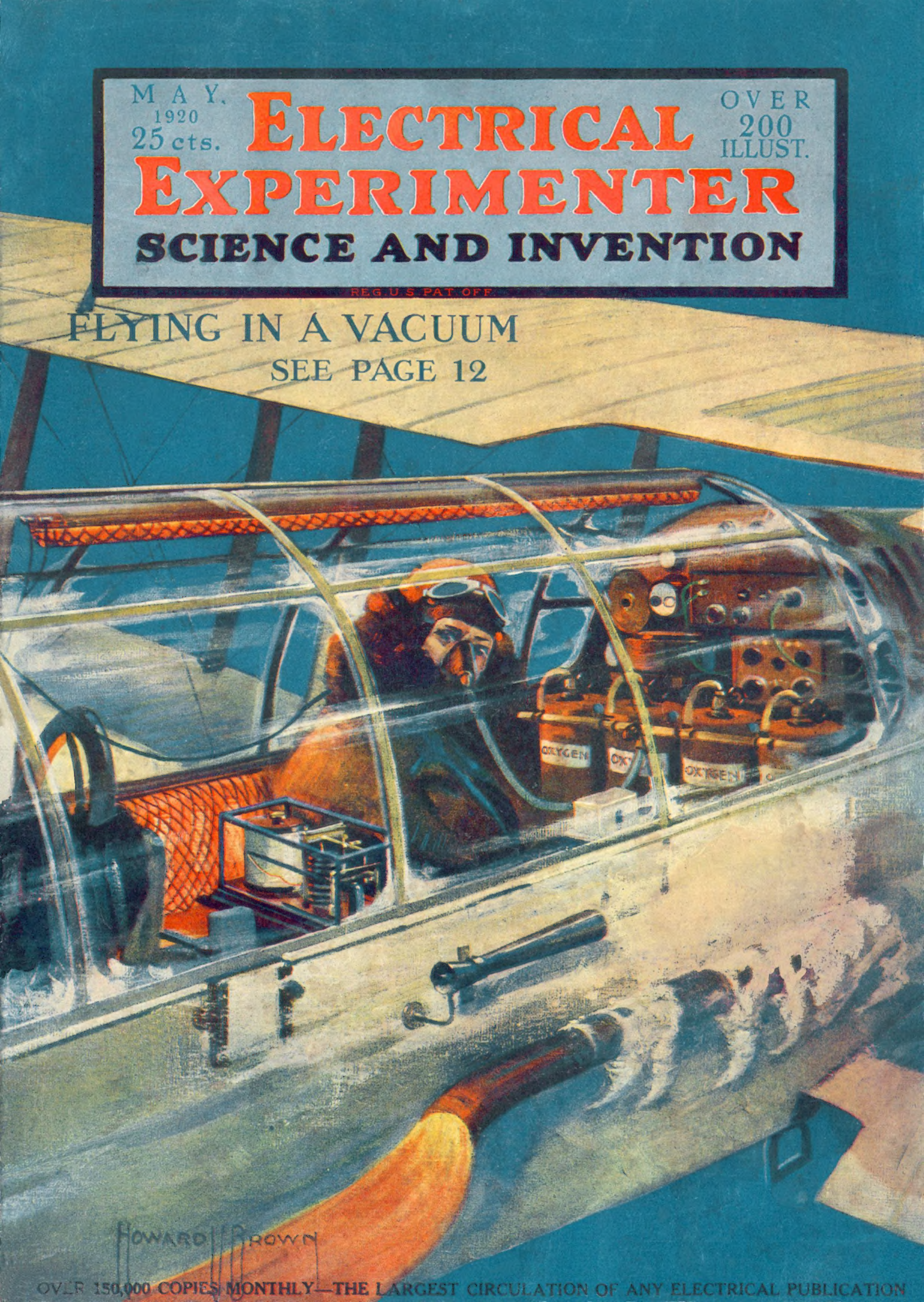

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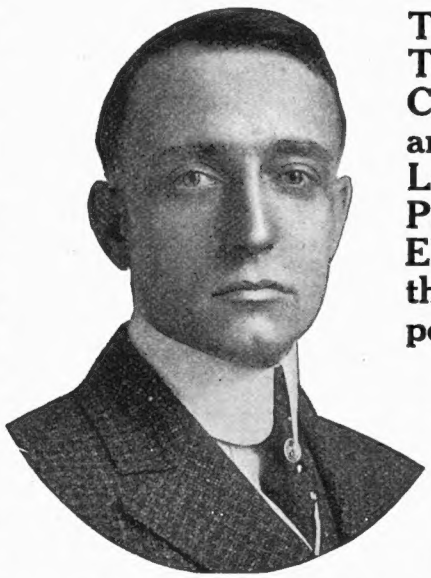

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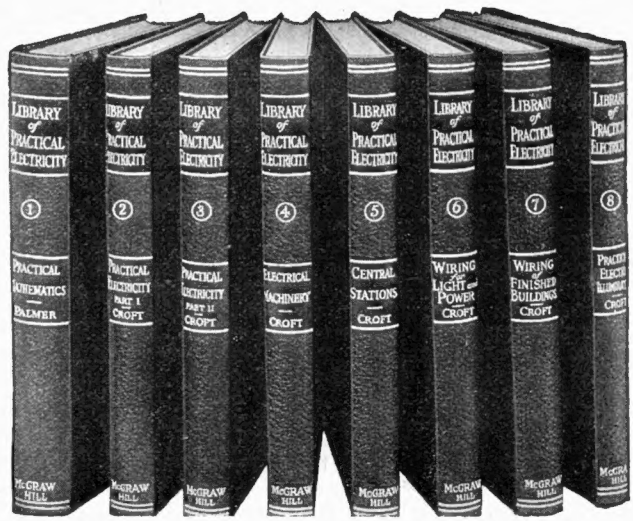
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EDITORIAL

The Sun's Heat

EVERY square mile of the earth's surface exposed to the sun's rays receives an average of over 500,000 kilowatts of energy continuously from our luminary. Imagine the sun stationed inside of a hollow sphere, the diameter of this sphere to be as big as the earth's orbit around the sun. Unquestionably every square mile of this unthinkably large sphere, measuring 182,860,000 miles across, would still receive 500,000 kilowatts of energy from the sun or a mere trifle of 52,524,064,195,680,000,000,000 kilowatts continuously. This figure is so tremendously large that the human mind can never grasp it. It is simply unthinkable.

So if we continue and state that recent researches tend to show that the temperature of the sun must be in the neighborhood of 13,500,000 degrees Centigrade, that statement, tremendous as its import is, leaves our imagination unsatisfied. We simply can not comprehend it, even tho we realize that the *hottest* temperature ever produced by man is but a trifling 3500 degrees Centigrade. Now compare the heat of the electric arc—the hottest man-made temperature—*i. e.*, 3500 degrees, with the sun's heat of 13,500,000 degrees. In other words, the sun is 3857 times hotter than our electric arc! Large as this titanic difference is, we fail entirely to grasp it—such are the limitations of the human mind.

Then, if we add that every single point of the sun—which is 852,908 miles in diameter—has been radiating this tremendous amount of heat continuously for millions of years, do we begin to realize that our facilities for grasping such cosmic facts are entirely inadequate.

But how then and thru which agency does the sun derive all this heat? We don't know. We can only speculate and theorize, but in no case can we say that we are sure. Nor can we prove or disprove many of the ingenious theories that have been adduced on the subject in the past.

Perhaps von Helmholtz's theory is the most satisfactory advanced so far, because it is the most difficult to disprove. This famous savant sought to prove that the sun's heat and energy were produced by the shrinkage of the flaming fire-mass. According to Helmholtz, the sun originally was a rather cold nebula, filling our entire planetary system. Gradually this mass assumed motion, becoming a spiral nebula. During this process it shrank gradually from a diameter of 5,491,996,000 miles (orbit of Neptune) to its present size of 852,908 miles diameter. Due to this contracting of the huge mass, unthinkable gravitational stresses were set up which in turn liberated heat, sufficient to account not only for the sun's great present heat, but a much higher temperature. As is well known, the sun has past its zenith some million years ago. It is now past the prime of its life, for if we use von Helmholtz's figures we find that at its hottest period the sun's temperature probably reached between 25 and 30,000,000 degrees Centigrade.

Other scientists in turn dispute the Helmholtz theory and maintain that it is not at all necessary to account for the sun's heat due to its shrinkage and contraction. They point out that the gravitational forces set up in the sun's interior, due to its ponderous mass, are sufficient to produce its great heat, and more. When a mass becomes as tremendous as the sun we may expect altogether different gravitational phenomena, as for instance those produced in a little pebble such as our earth.

Next we have the radium and the atomic theories. The former, namely, that the sun's heat is due to radium, is readily disproved by the spectroscope. The atomic theory cannot be proved nor disproved easily, because man has not produced atomic energy as yet and as a matter of fact we know nothing at all about it. From a purely philosophic standpoint, however, the atomic theory is probably the most plausible one. Time only can tell whether it will hold.

H. GERNSBACK.

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The **ELECTRICAL EXPERIMENTER** is publisht on the 15th of each month at 233 Fulton Street, New York. There are 12 numbers per year. Subscription price is $3.00 a year in U. S. and possessions. Canada and foreign countries, $3.50 a year. U. S. coin as well as U. S. stamps accepted (no foreign coin or stamps). Single copies, 25 cents each. A sample copy will be sent gratis on request. Checks and money orders should be drawn to order of EXPERIMENTER PUBLISHING CO., Inc. If you change your address notify us promptly, in order that copies are not miscarried or lost.

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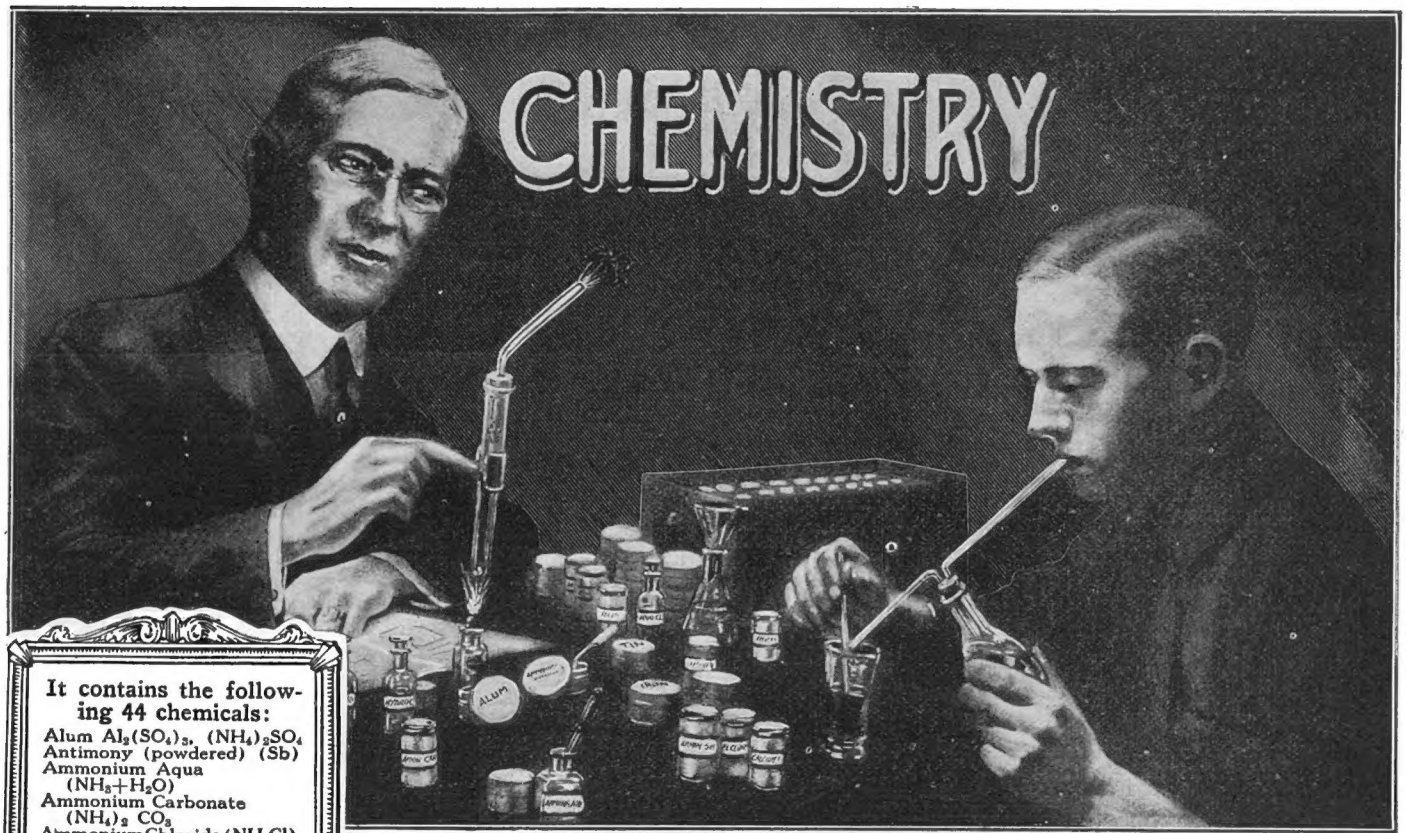

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Think over the names of successful people in every field of endeavor, and you will find that they have developed their personalities until they stand out from the hum-drum crowd.

On the other hand there are tens of thousands of people who live a mediocre existence, who travel along a groove—a "deadly parallel", who never impress others with their true ability simply because they have hidden their personalities under a bushel, have failed to develop the characteristics which would give them individuality.

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As one man put it—"he is irresistible."

Another instance is a young man who deals only with big people. He calls only on men of large affairs. Where men with ten times his ability fail to get even a hearing, this young man comes away with real business. His entire success is due to his personality.

Whatever your position in life, you have attained it through your personality. If you are earning big money, thank your personality. If you are plugging along, earning only about as much as you spend, *blame* your personality for it. For, whether we realize it or not, everyone of us has a distinctly different personality. The trouble is that we have failed to develop our personalities to their fullest possibilities.

It may be a fist-pounding energy.

Perhaps you have wondered what successful personality is. In simple language it is nothing more than *pleasing individuality*. And there are a thousand variations of it. One man's personality consists of extreme courtesy;

A smile that wins women as well as men.

another acquires personality through faultless dressing; another has dominating "pep"; still another person has a charming voice; another has a way of making the most difficult problems appear simple.

We each have our own personalities. One man wears an unusual style of linen collar and people notice him unconsciously on that account alone. A young woman has cultivated a smile that wins the hearts of her women friends as readily as it does men. A way of laughing—or a quiet, mathematical thoroughness, or a fist-pounding energy, or a suave smoothness—there are as many kinds of personalities as there are people. And those who develop their God-given traits are quickly marked as the kind of people you like to have around; the kind of people who succeed.

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About a year ago a certain young man was a bookkeeper. He was a conscientious worker, but he was the most "colorless" person imaginable! He seemed utterly commonplace. At the time, he was employed in a publishing house. He secured "Power of Personality" course and studied the lessons enthusiastically. To make a long story short, he became auditor of the publishing house in six months. A year later he received an offer from one of the largest lithographic printing concerns in the world to become its Financial Vice-President at $10,000 a year. Another man, who has developed his personality to complete success was always regarded as a rank failure. All his life, from boyhood to the age of fifty, he has worked and slaved. He is a construction engineer—but he seemed to always just miss success. He was in debt, with a son and daughter to educate. He read the lessons thankfully. In a few weeks he learned to assert himself—to claim success as his birth-right. Then he got a contract to build a big steel bridge—from the very concern who turned him down the year before! He completed it successfully and profitably. Since then more big commissions have *come* to him, for nothing succeeds like success. People say in wonder, "I didn't think he had it in him!" He had it in him all right. He only needed to develop his true personality! Now he is happy, prosperous and on the way to be rich—but he regrets that he didn't have the "Power of Personality" lessons years ago.

Financial vice-president at $10,000 a year.

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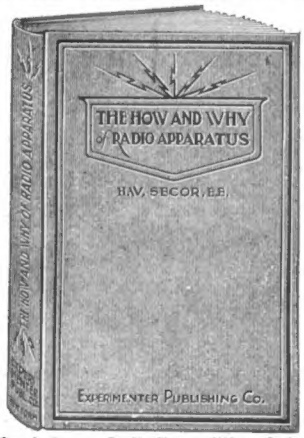

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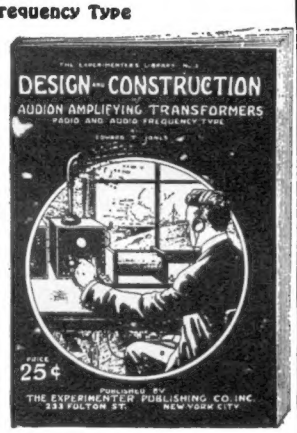

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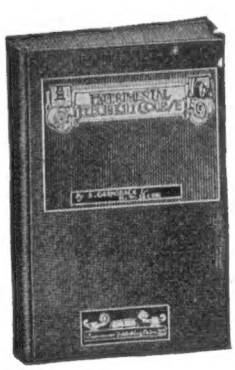

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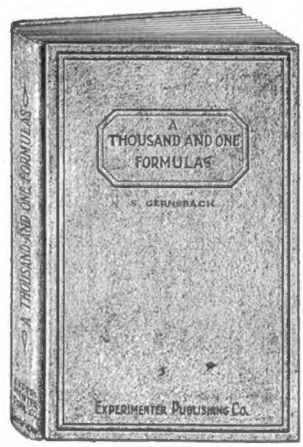

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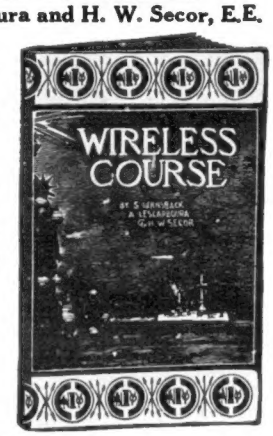

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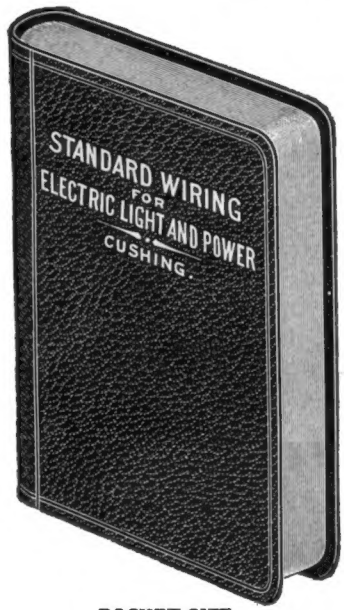

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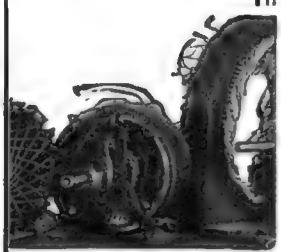

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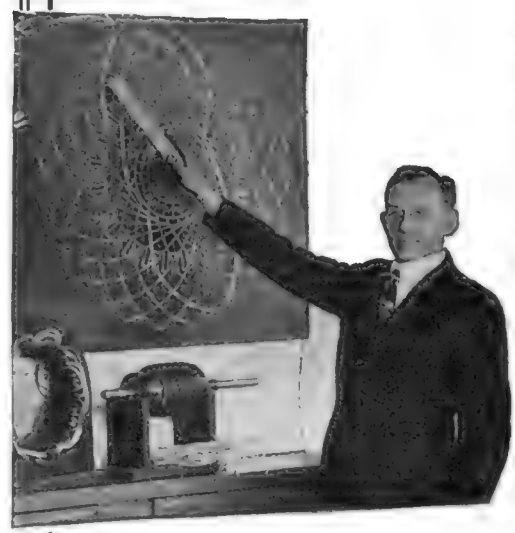

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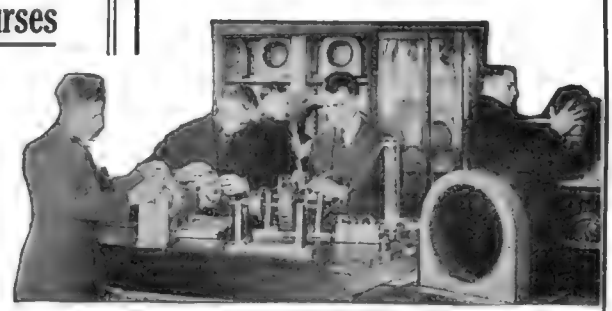

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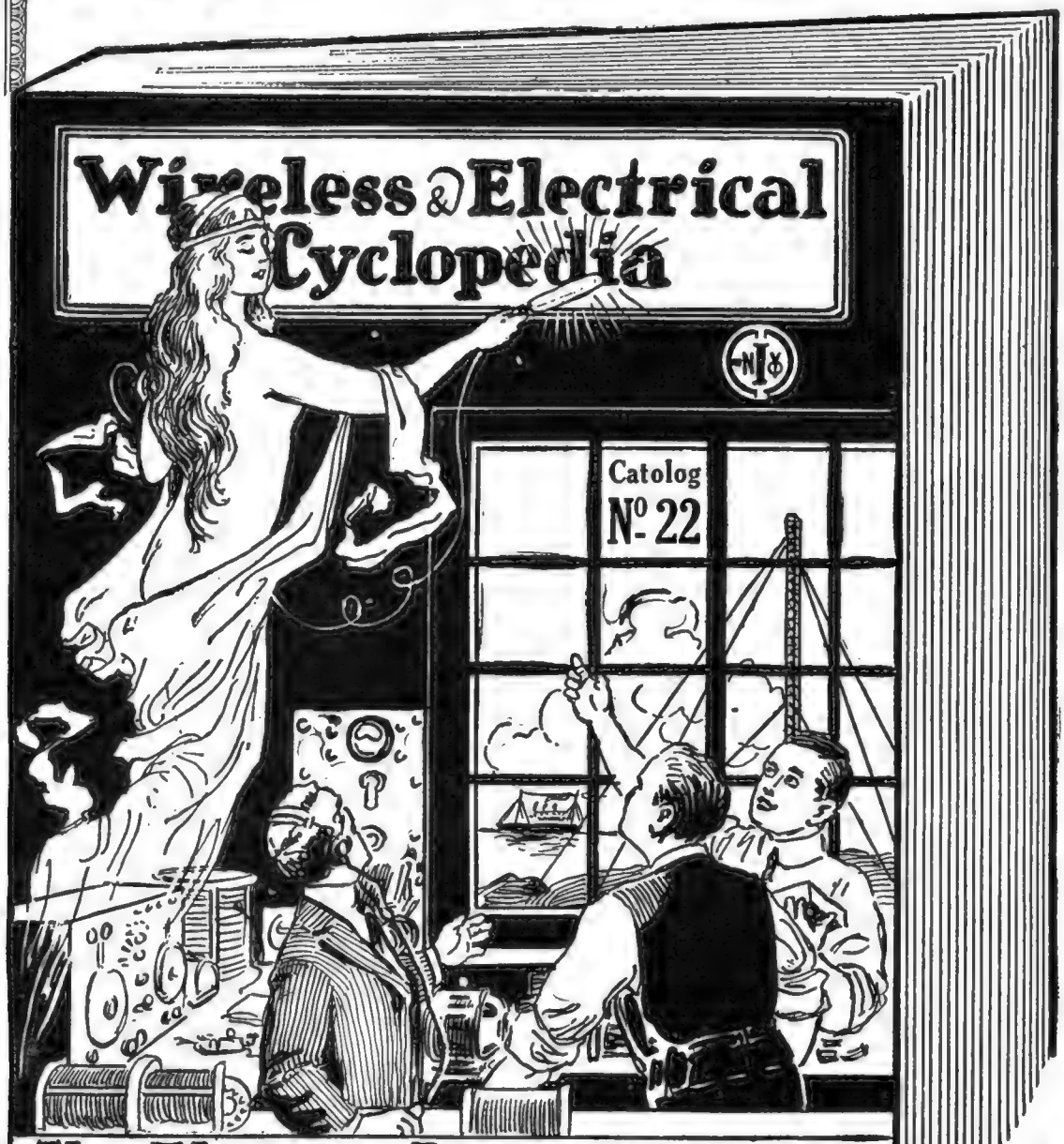

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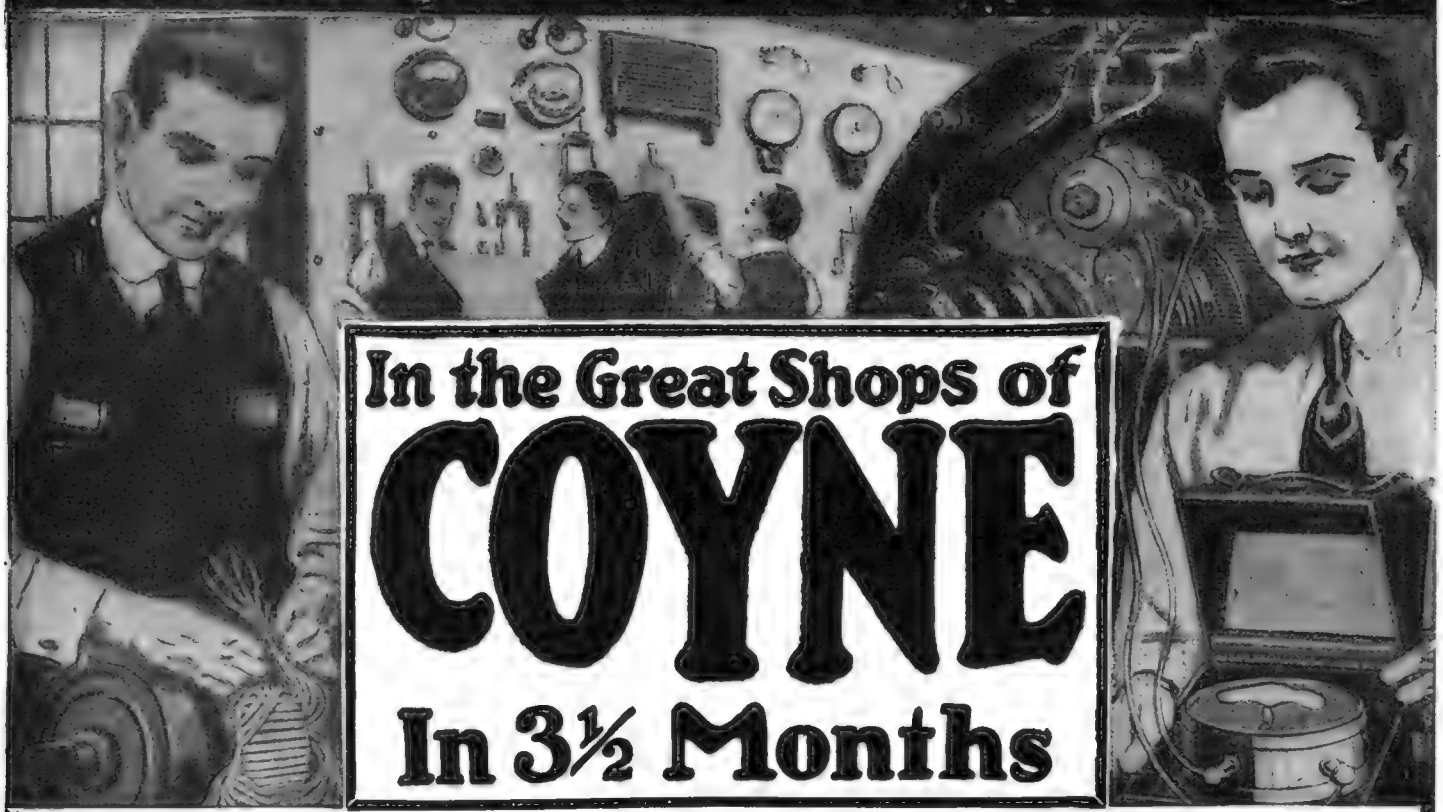

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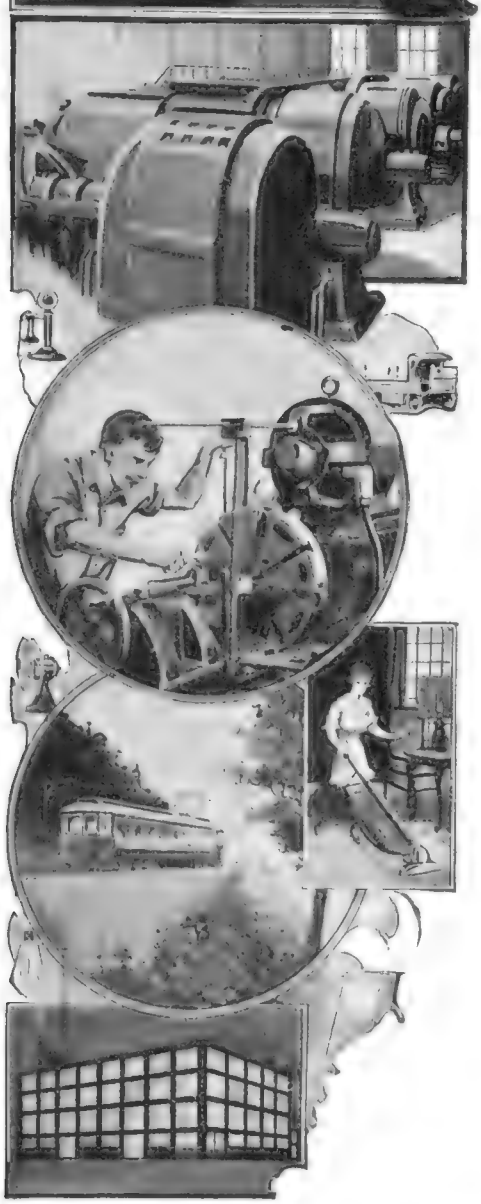

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ELECTRICAL EXPERIMENTER

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Vol. VIII. Whole No. 85 May, 1920 No. 1

Cutting the Boche Electrified Barbed Wire

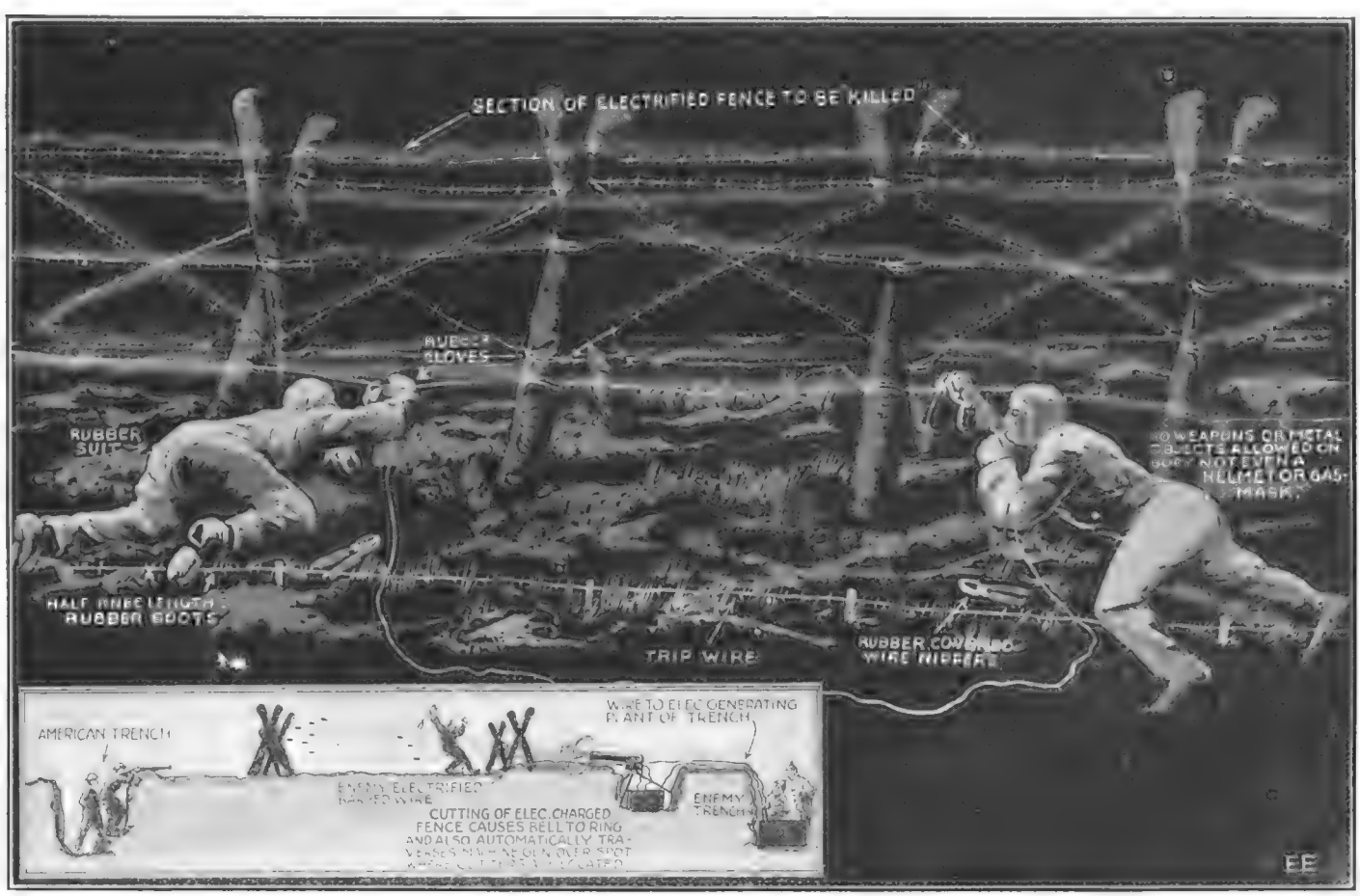
By VAN LOUIE MARTIN
51st Inf., 2nd Bat. Scouts, U. S. A.

IT was in the fore part of September, 1918 and we were in reserve at the famous Schluct Pass in the Vosges Mountains, province of Alsace, and near the French, Germany and Switzerland boundary line. We were overlooking the little city of Münster and were quartered amongst batteries of French mountain guns that had been firing, undetected, upon the enemy front lines, six kilometers away, from these same positions for about four years.

One afternoon, at about the close of day, when the cold rain was pouring down,—and it rained in France 330 days out of a possible 365 during 1918 (Brest Official Report)—and they call it "Sunny" France,—we started our weary hike to a point in the front lines about ten kilometers away, overlooking the little village of Orbey. We were not allowed to stop for a rest on this hike as we were, of course, well within enemy artillery range all the way, and we were to relieve the French troops before daybreak the following morning. We had no mishap until arriving at Las Noir; (Black Lake) here we were led by a French guide down the bed of a diverted mountain stream camouflaged on both sides and overhead. The guide, knowing the terrain so well, naturally led us faster down this rocky stream bed than we could follow, and altho each man was trying to hold onto the pack of the man stalking along in the dark in front of him,—we were from necessity taking it "Indian" fashion, or single file—several platoons became disconnected from the main body.

In spite of delays one o'clock found us all stationed at our designated places in the front line trenches and by three o'clock

(*Continued on page 76*)


SECTION OF ELECTRIFIED FENCE TO BE KILLED
RUBBER GLOVES
RUBBER SUIT
HALF KNEE LENGTH RUBBER BOOTS
TRIP WIRE
RUBBER COVERED WIRE NIPPERS
NO WEAPONS OR METAL OBJECTS ALLOWED ON BODY NOT EVEN A HELMET OR GAS-MASK
AMERICAN TRENCH
WIRE TO ELEC GENERATING PLANT OF TRENCH
ENEMY TRENCH
CUTTING OF ELEC. CHARGED FENCE CAUSES BELL TO RING AND ALSO AUTOMATICALLY TRAVERSES MACHINE GUN OVER SPOT
EE

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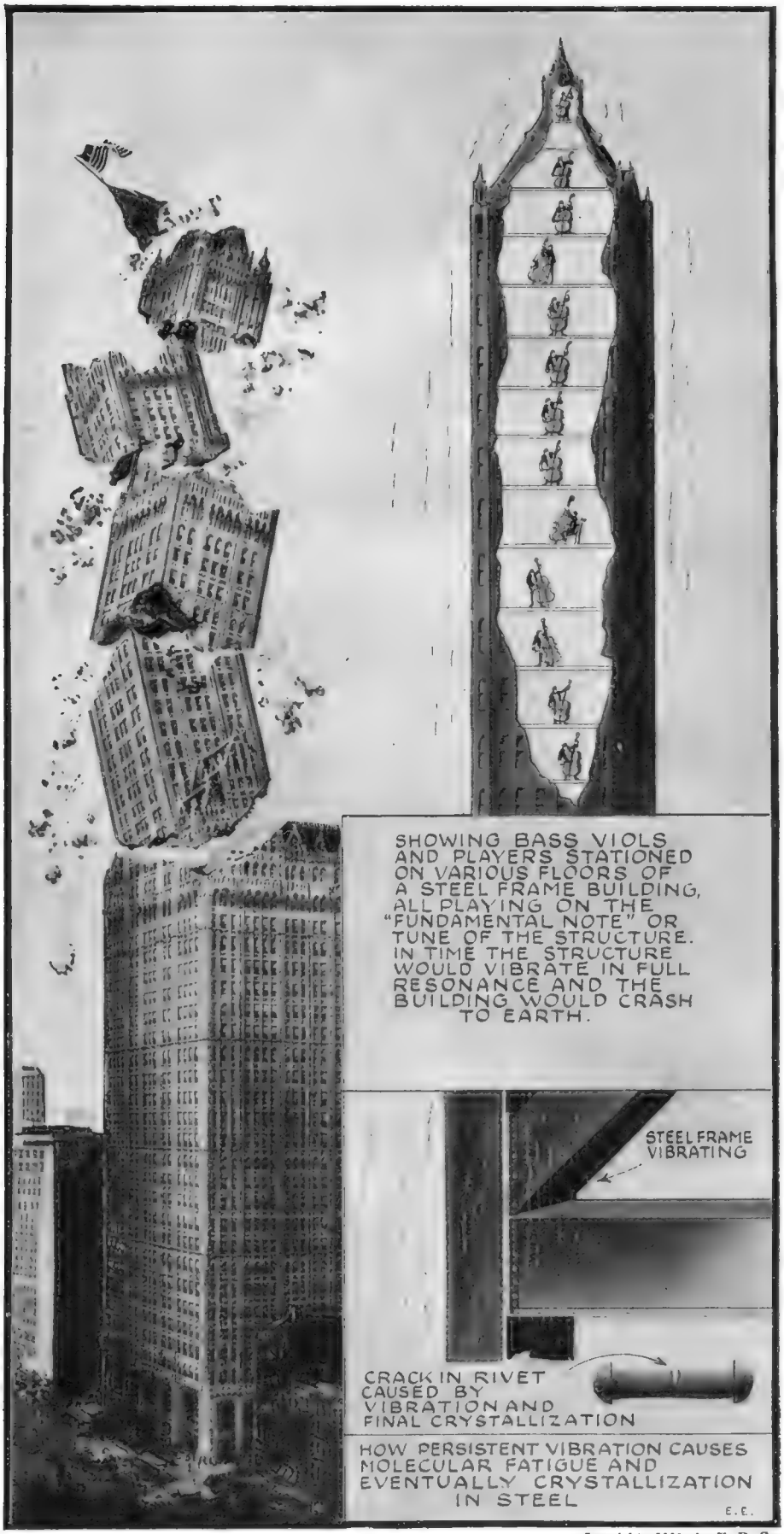
The Exciting and Life-Risking Business of Cutting Boche Electrified Wire Fences Is Here Narrated for the First Time by a Man Who Actually Did It.

Oddities of Sound

By H. WINFIELD SECOR

Some of the marvelous things that sound or vibration can accomplish are here described. For example, do you know that it is possible to "play down" a steel skyscraper by placing a bass-viol on certain floors? Do you know how to tell how far a train whistle is, by timing it? What causes an echo? How the phonograph talks?


SHOWING BASS VIOLS AND PLAYERS STATIONED ON VARIOUS FLOORS OF A STEEL FRAME BUILDING, ALL PLAYING ON THE "FUNDAMENTAL NOTE" OR TUNE OF THE STRUCTURE. IN TIME THE STRUCTURE WOULD VIBRATE IN FULL RESONANCE AND THE BUILDING WOULD CRASH TO EARTH.
STEEL FRAME VIBRATING
CRACK IN RIVET CAUSED BY VIBRATION AND FINAL CRYSTALLIZATION
HOW PERSISTENT VIBRATION CAUSES MOLECULAR FATIGUE AND EVENTUALLY CRYSTALLIZATION IN STEEL
E. E.

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THE subject of *Sound* is one of the most entrancing in all the ramifications of pure and applied science today. Quite a little has been written on sound from time to time, and yet, all in all, really very little has been told concerning it. There are several excellent works, including those of Tyndall, Miller and other authorities, which cover the usual physics of sound, a subject with which we are all concerned, and about which we know so little. The study of the human ear, for example, is one of the most absorbing studies in all medical science,—not the dissecting or analyzing of the ear structure itself, but the complete study of "just how we hear." We will not concern ourselves here, however, with the orthodox aspects and physical studies of sound, which can be found in the text-books treating on the subject, but will confine our present introspections to the outstanding oddities of the science of sound, or what is the same thing,—*Vibration!*

Fig. 2. What's This! The 100,000 Ton Woolworth Building Broken to Bits and Falling into Broadway?—and We Never Read It in the "Squeedunk Herald"!! Well, It Hasn't Happened Just Yet, but It Might. Every Steel Frame Structure Has a Vibrant Musical Note of Its Own. If You Once Ascertain This Fundamental Note of the Structure and If You Can Set It Vibrating at Full Resonance on This Tune, the Structure Will Vibrate so Powerfully Eventually, That It Would Fall to Pieces. A Scientist Some Years Ago, Calculated That If We Could Place a Bass Viol on Certain Floors of a Skyscraper, and If All of These Istruments Were Played for a Considerable Period Persisteatly on the Fundamental Note of the Building, Say "B. Flat", That the Structure Would Eventually Disintegrate and Fall Apart. The Inset Figure Shows Another Little Known Phase of Vibration and What It Will Do. Experience Has Shown That Where Vibration Exceeds a Certain Limit, the Very Best Steel Will Start to "Crystallize." Other Materials Are Similarly Affected, and Crystallization Will Cause Cracks to Develop in Rivets and Other Members, as Experience Has Shown. At the San Francisco Fire and Earthquake Catastrophe Some Years Ago, the Power of Vibration Was Wonderfully Illustrated. Some of the Tall Skyscrapers Were Shaken Until Every Stone and Piece of Mortar and Flooring Was Shaken to the Ground; but the Steel Framework Held Its Head Aloft Thru It All. Of Course, in This Case the Vibration Was Much More Severe Than Would Be Produced by Any Ordinary Means.

A sound of a certain pitch has a different corresponding frequency in vibrations per second in the air, or solid body in which it originates, also as is well known, there are certain well defined limits above and below which the human ear will not interpret sound as such. Normally, the human ear does not recognize sounds below 16 vibrations per second, nor those above 25,000 vibrations per second. The lower the pitch of the sound, such as a bass note, the lower the vibration period; while the higher the pitch, the higher the vibration rate. Middle "C" on the piano has a vibration corresponding to 259 vibrations per second. The fourth octave above middle "C," has a vibration period of 4,138 vibrations per second, while the fourth octave below middle "C" or low "C," has a vibration frequency of 16 per second. Practically all of our music is written in between these limits.

DEMONSTRATING THE POWER OF MUSICAL VIBRATION.

It is very easy to demonstrate the great power of musical vibration or vibrations in general, by the aid of two tuning forks.

Every high-school student has performed this experiment, but it is not so well known but that it will bear repeating here, especially in the demonstration here described. To appreciate just what this experiment is, one should, if possible, procure two small tuning forks, four to five inches long. The tuning forks are usually placed on resonant wooden bases, preferably open at one end, and the two openings of the transmitting and receiving forks arranged to face one another. In the laboratory, the tuning fork is usually struck on one of the free prongs with a felt hammer, so as to give the maximum vibration at the natural frequency of the fork, without interfering with the degree and period of the sound given forth by the fork when struck. If one of the forks is now struck smartly on the edge of the table or else hit with a small hammer, it will sound its natural note, say "A," and if the second tuning fork is of the same identical pitch, then it will be ascertained that the two forks can be placed at a considerable distance apart, in some instances placed across the room; and the vibrations set up in the air by the first fork, will be transmitted and caused to act upon the second fork, which will then start vibrating and give forth a sound of its own.

Vibration (probably not always but usually within the range of audibility,—that is between 16 and 20,000 vibrations per second) has often caused much mischief in engineering and other structural work. A little vibration is a dangerous thing, not in itself perhaps, for the originating source may be very small as to magnitude, but this may cause a larger structure to start vibrating—and once a large structure, such as the frame of a building or bridge has started to vibrate at its own natural period or fundamental note, (and every building or bridge structure possesses its own fundamental note), there may be trouble brewing, once the vibration has reached a fully resonant state and the amplitude of the various members has attained a maximum.

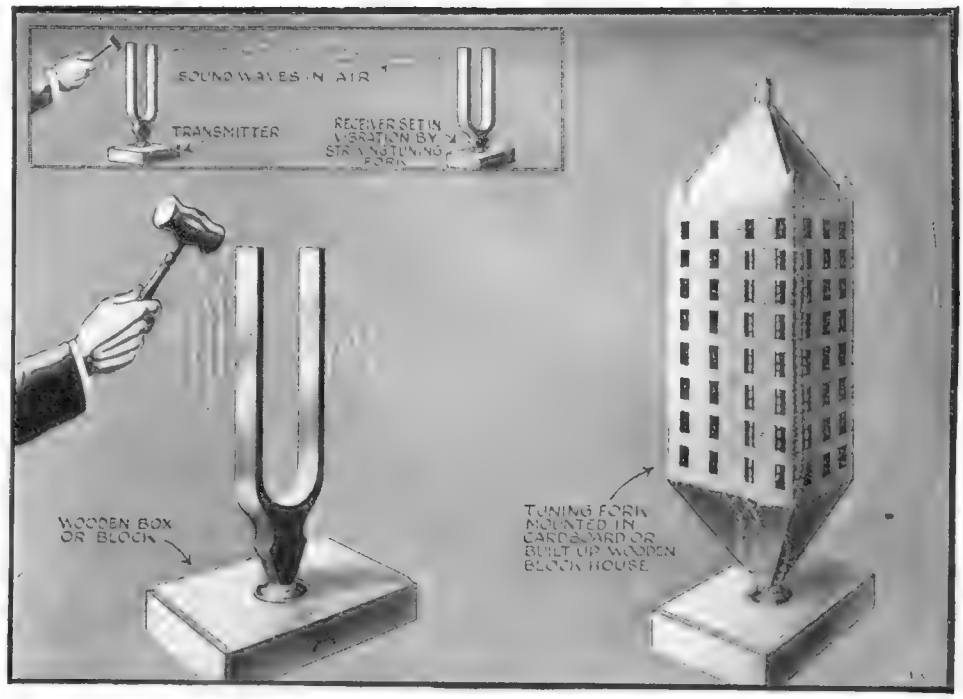

SOUND WAVES IN AIR
TRANSMITTER
RECEIVER SET IN VIBRATION BY SYMPATHETIC TUNING FORK
WOODEN BOX OR BLOCK
TUNING FORK MOUNTED IN CARDBOARD OR BUILT UP WOODEN BLOCK HOUSE

Fig. 1. The Small Inset Cut Shows How Two Tuning Forks of the Same Pitch Can Be Used to Demonstrate the Wonderful Phenomenon of Acoustic Resonance or "Sympathetic Vibration." If the First Tuning Fork Is Struck with a Felt or Other Hammer, the Second Tuning Fork Will Be Set Into Vibration. Mounting the Tuning Fork on Hollow Wooden Boxes Will Give Much Greater Sound, and in Most Cases the Ends of the Boxes Are Open. For This Experiment the Open Ends Should Face Towards One Another. The Larger View Shows How the Same Experiment Can Be Performed in a Very Interesting Manner, to Show in a Small Way, How a Steel Building Structure Can Be Vibrated by Sound Only, Until It Falls Apart. The Tuning Fork Is Mounted in a Free Wooden Base so as to Rest on the Box as Shown. On This Base a Miniature Building May Be Constructed of Small Wood Blocks and When the First Tuning Fork Shown, Is Struck the Second Fork Inside the Building Will Start Vibrating. When It Reaches Full Resonance, the Building Will Collapse and Fall Over. A Very Beautiful Experiment!

SKYSCRAPERS COULD BE DESTROYED BY SOUND ALONE!

A very interesting experiment which is nothing else but a demonstration on a small scale of the undreamt of power of vibrational force, is illustrated at Fig. 1. To perform this experiment, a small cardboard skyscraper may be mounted on a wooden pedestal of the shape shown, with the second tuning fork mounted inside of it. The tuning fork is mounted firmly in the wooden base, and this base rests in a free position on the receiving block or resonant chamber as shown. Now, when the tuning fork at the left is struck with the sounding hammer or otherwise vibrated, the second fork will start vibrating, the amplitude of vibration depending upon the distance from the originating fork, and eventually the miniature building will topple over. In some ways this is perhaps but a crude illustration of vibrational force as applied to a large building, but it at least gives us some practical idea of this phenomenon.

Several years ago, one of our greatest experts on musical sounds and the tremendous forces of vibration, stated that he could "play down" a skyscraper such as the Singer tower, or the Woolworth building, in New York City, simply by placing musical instruments, such as bass-viols, on each floor or on certain floors, and in certain parts of the building. The theory of this action is as follows: He would first determine by calculation or otherwise, the fundamental note of the entire structure, which would probably be very low in the tonal register. Then the musicians would all start playing their instruments on this fundamental note, and keep it up. Of course, this really is a theoretical consideration but under certain conditions the main possibilities of such an experiment are very logical and plausible. It might take quite a little time to get the whole structure vibrating at its natural frequency, but once it did, it would be high time for the tenants on the fifty-fourth floor and the lower floors of the Woolworth building to scuttle earthward, for there would shortly be a shower of bricks, stones and mortar from the entire structure into the street. At this juncture a very startling and parallel incident comes to mind and shows what vibration really can do. At the time of the San Francisco fire and earthquake, the author remembers having seen photographs of the tall buildings, one of about sixteen stories, which had been shaken by the earthquake or *vibrated*, until all of the stone work, floors, etc., had been shaken free from the steel frame, leaving absolutely nothing but the steel frame complete—stretching upward in the air like a Martian giant ready to stalk over the world, à la H. G. Wells.

All of these vibration stresses are taken into consideration by engineers and architects who design tall buildings, particularly skyscrapers, especially where the ground is vibrated under them constantly by subways, as in our large cities. In the ordinary building structure, where the steel frame is covered with stone and other building materials, these all help to absorb any vibration set up in the metal framework, in the same manner as the hand or any other part of the body touched against a vibrating tuning fork absorbs the vibra-

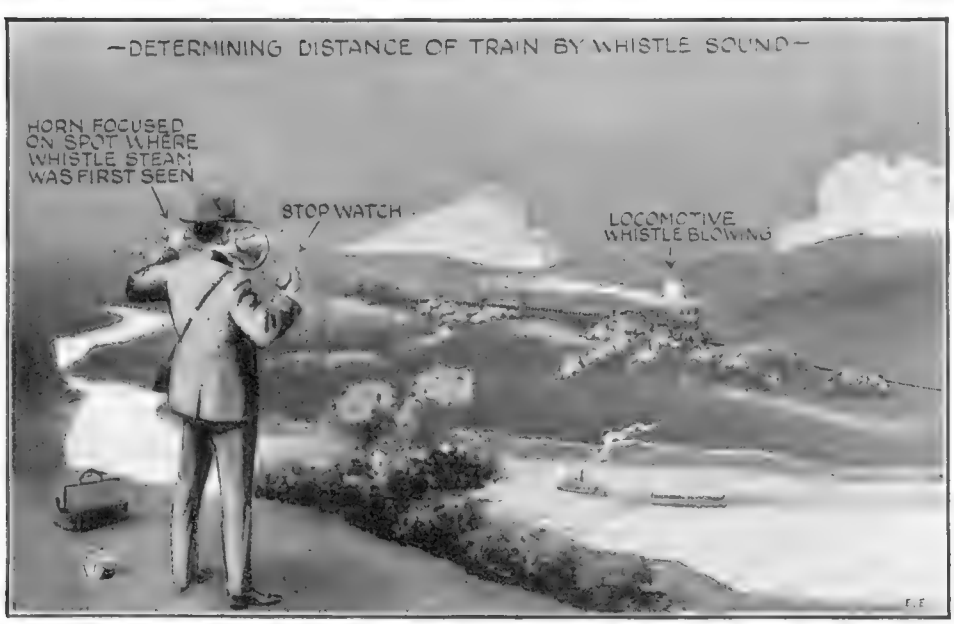

—DETERMINING DISTANCE OF TRAIN BY WHISTLE SOUND—
HORN FOCUSED ON SPOT WHERE WHISTLE STEAM WAS FIRST SEEN
STOP WATCH
LOCOMOTIVE WHISTLE BLOWING

Fig. 4. A Very Interesting Phenomenon of Acoustics or Sound Is That Here Illustrated. By Knowing the Time When the Steam from a Locomotive Whistle Is First Seen, and the Time When the First Sound Is Heard, the Distance of the Whistle Can Be Readily Calculated by Simple Arithmetic. The Velocity of Sound in Feet Per Second Is Multiplied by the Number of Seconds Elapsed, Between Seeing the Steam and Hearing the Sound.

METAL PICTURE FRAME, GLASS VASE, ETC. ETC. SET IN VIBRATION BY PIANO.
-THE UNMUSICAL PARLOR- EVERY OBJECT VIBRATES AT ITS OWN FUNDAMENTAL OR NATURAL VIBRATION PERIOD.

Fig. 6. The Un-Musical Parlor: If You Have Heard Any Strange Noise Which Jarred on the Ear When Your Piano Is Being Played, Look Around for Glass Vases, Metal Picture Frames, or in Fact Anything Made of Metal or Other Hard Materials such as Brass, Porcelain, etc., All of Which Have a Fundamental Vibrating Note of Their Own, Altho You May Not Think So. In Some Cases, the Object Will Vibrate So Strongly That It Has to be Removed from the Piano or from in Proximity to the Piano.

tion of the fork, and brings it to a stop very quickly. The arrangement of the musicians and their bass-viols for vibrating a steel structure according to this theory is shown at Fig. 2.

VIBRATION IN BRIDGES.

As just pointed out the building materials which cover the steel frames of our office and factory structures serve to absorb the majority of any ordinary vibrational forces set up in the steel framework, and thus prevent anything approaching a disastrous collapse of the building; but when it comes to *bridges* there is no such absorption of the vibration and you will always note a great deal more free movement in all of the various steel members of a bridge no matter of what size.

In some cases, especially on large bridges like the Brooklyn Bridge over the East River in Greater New York, the vibration may take on the nature of a long, slow swing, which might be so gradual as to pass unnoticed by the human senses. However, you will often notice the vibration in a bridge distinctly, even where the bridge rests on properly spaced piers, every time a wagon or automobile goes trundling across the planking, and oftentimes in this connection you will become aware of a certain peculiar note, which if you had the correct apparatus to check it up with, would tell you what the exact register of this note is; which might possibly be the fundamental note of the whole bridge structure, or again it might be simply the fundamental note of a certain part of the structure, depending upon the conditions.

This matter of vibration and the tremendous forces which may result from rhythmical repetition of certain vibrational or musical notes, if you want to call them that, is always kept in mind by military men. Every soldier who has ever marched across a pontoon or in fact any bridge will undoubtedly recollect the method and the orders given for carrying out this procedure. The first and most important thing in marching a body of troops across a bridge, especially a small or lightly constructed bridge, is to have them *break step*. If the soldiers are marched across such a bridge in their regular step—tramp, tramp, tramp—the result will be that the rhythmical wave of vibrational force will travel along the length of the bridge, and grow stronger and stronger as the steady beat of the marchers persists—and eventually, perhaps in a few minutes, the bridge will be heaving up and down like a teacup on the ocean and break up or collapse. Fig. 3 illustrates this phenomenon very vividly. At "A" we see how the bridge sways as the troops march across *in step*. At "B" the successive and constantly increasing amplitudes of the vibrational waves creeping along the length of the bridge is clearly depicted, while at "C" the proper method of marching soldiers across a bridge is shown under the command of *break step!*

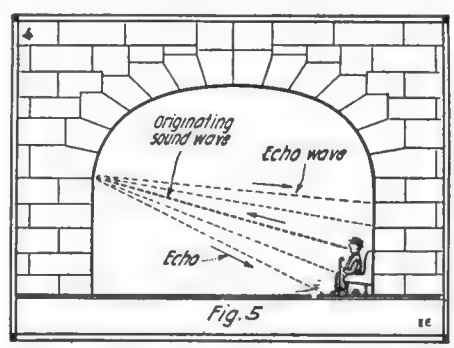
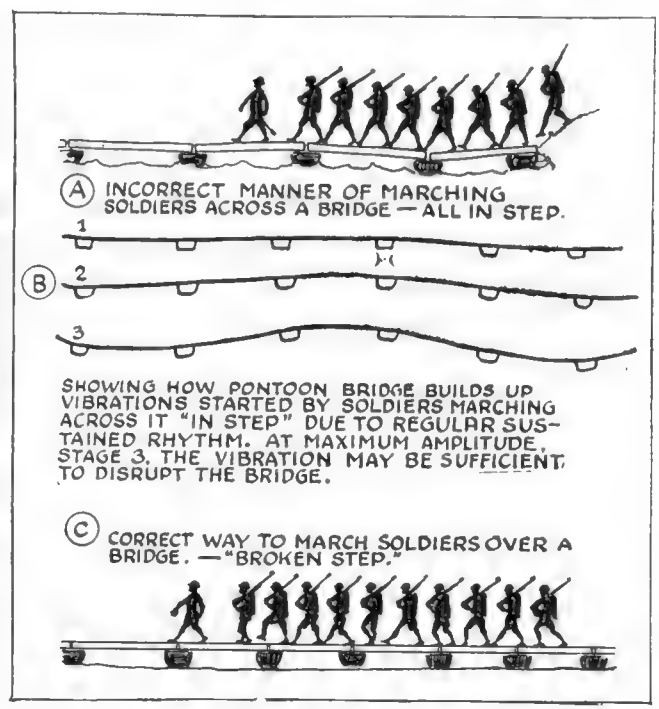


Fig. 5. The "Echo," with Which We Are All Familiar, is Caused by a Sound Wave Being Reflected. We Often Notice This Effect in Stone Archways in Public Parks, or Wherever There is a Hard Resonant Surface Against Which the Sound Can Impinge and Then Be Reflected.

Fig. 3. This Shows the Various Stages of Vibration as Set Up in a Bridge, When Soldiers Attempt to March Over it with Each File of Men "In Step." The Order is Always Given to "Break-Step," When Soldiers March Over Bridges, Whether Large or Small, to Prevent the Chance of a Regular Rhythmic Vibration Being Set Up Which Would Eventually Attain Such an Amplitude as to Cause the Bridge to Break Into Sections. Every Military Man is Made Thoroly Familiar with This Vibratory Effect Early in His Career.


A INCORRECT MANNER OF MARCHING SOLDIERS ACROSS A BRIDGE — ALL IN STEP.
1
B 2
3
SHOWING HOW PONTOON BRIDGE BUILDS UP VIBRATIONS STARTED BY SOLDIERS MARCHING ACROSS IT "IN STEP" DUE TO REGULAR SUSTAINED RHYTHM. AT MAXIMUM AMPLITUDE, STAGE 3, THE VIBRATION MAY BE SUFFICIENT TO DISRUPT THE BRIDGE.
C CORRECT WAY TO MARCH SOLDIERS OVER A BRIDGE. —"BROKEN STEP."

It is of course evident that with the *broken step*, i. e., the successive files of soldiers taking their steps at different moments precludes the possibility of a rhythmical vibration being set up and prevents it from becoming of dangerous proportions. Another peculiar result of sustained vibration, even tho it may be more slight in nature and almost not noticeable even to an inspector of steel building and bridge structures is *crystallization*.

Several years ago the writer had an opportunity of seeing just what crystallization really can do under the lashwhip of sustained but minute vibrational forces. Referring to one of the detailed illustrations at Fig. 2 we see how crystallization caused by vibration will crack iron rivets and not only rivets, but even steel beams which are subject to such action as well as shafting and other metal members.

In one case, which the writer saw at first hand, an electric motor armature of considerable size had all of the lead wires connecting the coils to the commutator broken off every two weeks. They would not all be broken off at once, but a great many of them would be severed, and upon examination by a chemical expert he pronounced the cause as due to severe and persistent vibration which had caused *crystallization* of the copper conductors. The ends of these conductors where they broke off or parted were crystallized just like balls of fine glass, even under the microscope. This trouble was finally remedied by changing the toothed gear drive from this armature to a smooth and less vibrational chain drive. Also the electrical experts finally decided on replacing all of the *solid* copper wire leads connecting the coils to the commutator by stranded conductors made of many fine wires or small cables.

DETERMINING DISTANCE BY VELOCITY OF SOUND.

The velocity of sound in air, when the temperature is 70° Fahrenheit, is 1,132 feet per second. At the freezing temperature the velocity of sound is 1,090 feet per second; that is, at 32° Fahrenheit. The velocity of sound in salt sea water, as used in submarine signaling, is approximately 4,000 feet per second. Musical sounds of different pitches are all propagated in the open air with the same velocity. Explosive sounds and sounds confined as in tubes are propagated with different velocities.

(*Continued on page 72*)

A Bullet-Proof Searchlight Reflector

By EDWIN F. LINDER, M.E.

MANY ingenious contrivances have been produced under the stress of the unusual circumstances which have always accompanied the wars waged by nations during the various periods of history. The recent great conflict was no exception to this natural tendency in stimulating the inventive traits of the scientific members of both the civil and military groups opposed to each other. It can therefore be safely assumed that the great magnitude of the last military campaign, in which so many millions of people were engaged, presented a much larger field for the development of suggestions for military use than any other previous war. Perhaps, at the close of actual combat, more than *one hundred thousand schemes* were under consideration by the officials of the allied governments and by engineers and other private professional enterprises engaged in the production of supplies and equipments for the armies in the field. Thousands of experiments were made along heretofore unknown lines of military action; a number of these efforts were crowned with success, yet the vast majority proved of little use when put to the terrific test of the battlefield. However, the benefits gained by the opportunities presented to observe the deficiencies of the countless number of devices will serve to build up better and more effective equipments for future protection.

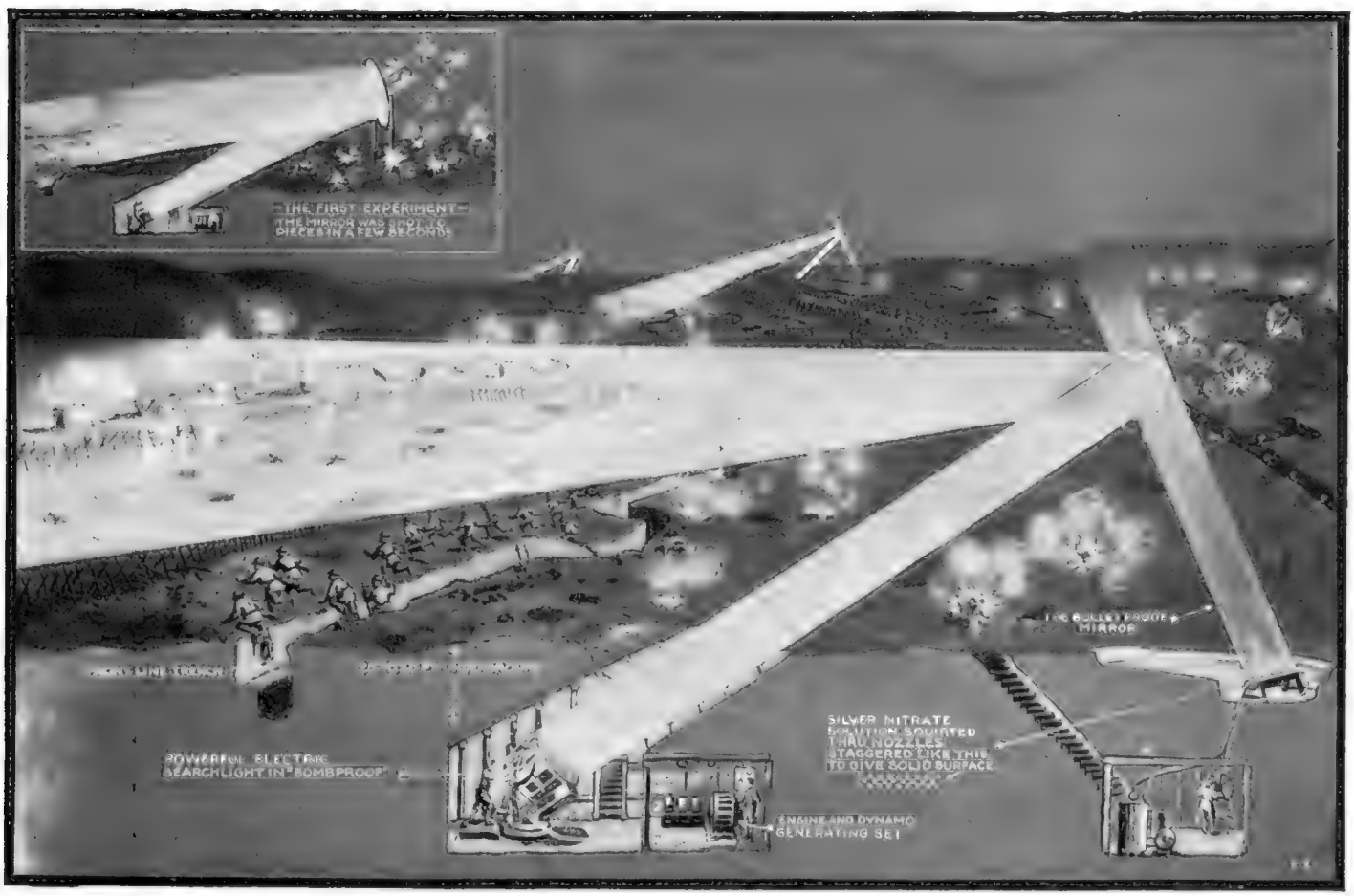
THE SEARCHLIGHT IN WAR.

During the early stages of the war the searchlight was found to be of great service in sweeping over the territory beyond the front trenches, known as "No Man's Land." Here it was found extremely difficult to protect the apparatus from the alert marksman stationed behind the enemy's line. Every imaginable ruse to hide the location of the searchlights was resorted to, such as shifting them from place to place; using several close together, operating one—then shutting off the light by shutters and putting the others into action—yet it would not be long before the enemy range-finders would find the mark and finally a well placed shot would end its career, the wrecked equipments of the Allies' forces and also to furnish better devices for our own army.

The then existing models of searchlights, which had proved to be defective, were replaced by many new types of design. Experience of the staff officers in the field pointed out that what was required to improve this branch of the service were designs that would produce searchlights that could be operated under cover of some kind of overhead protection, and at the same time enable our army experts to direct the beam at will toward the enemy. This type of light was sought for trench use where the beam was to be usually rotated on a horizontal plane.

After much study a type was actually constructed by an American concern in which the chief improvement was the mounting of a plain glass reflecting mirror that could be pivoted to the desired angle on a long tube. When in use, the only parts exposed to the gun fire and snipers of the enemy was the plain mirror. This scheme of course protected the major part of the apparatus from damage to a greater extent than the former models—but soon was discarded, as the exposed position of the second reflector served as an excellent target, and once shattered placed the plant out of commission. (The insert in the illustration gives a very good idea of what happened every time the plain mirror would be raised above the top of a trench.

(*Continued on page* 66)



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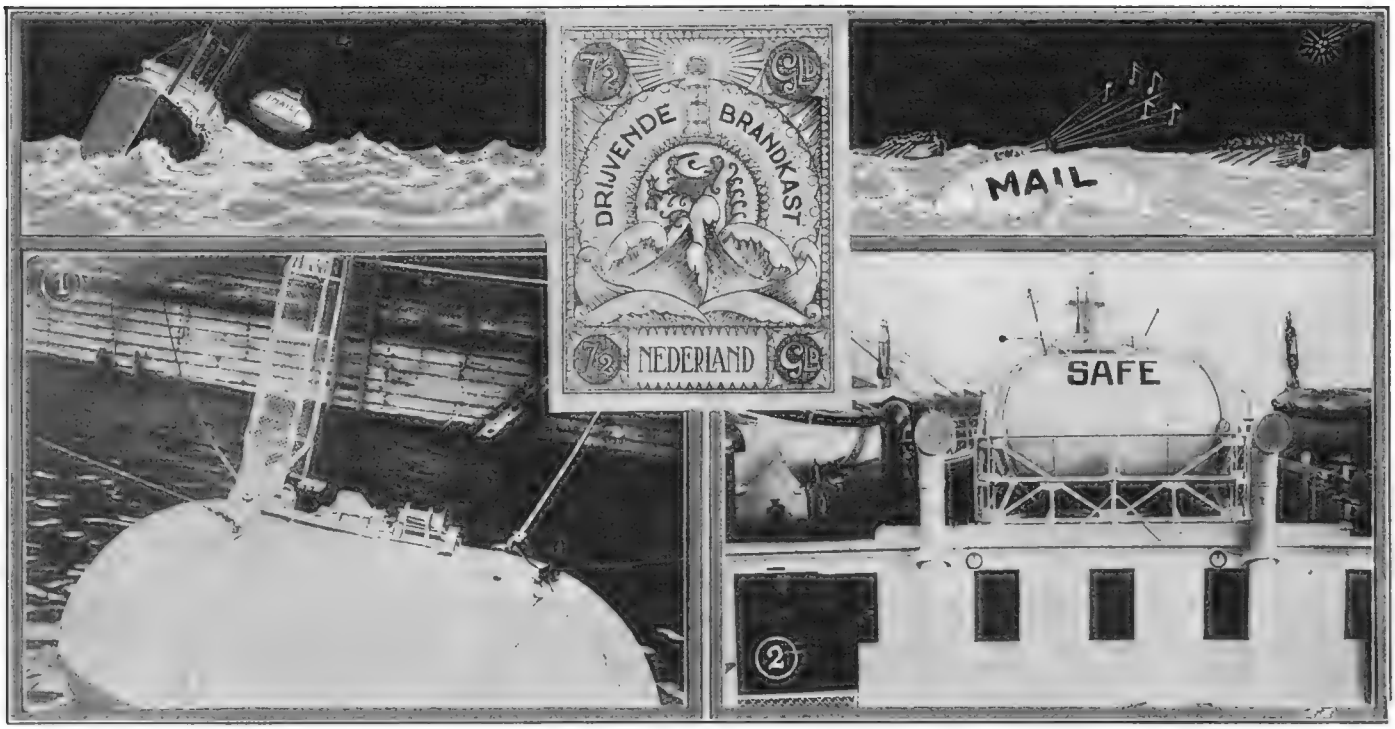
A Bullet-Proof and Shell-Proof Mirror by Means of Which It Becomes Possible to Reflect Searchlight Beams Across "No-Man's-Land" Into the Enemy Territory Has Become a Reality, Thanks to the Invention of the Present Liquid Mirror. The Searchlight Is Placed Well Under the Ground in Such a Position That It Is Very Difficult to Destroy, Even by Shell-Fire. The Mirror Is Composed of Fine Jets of Mercury or Other Suitable Liquid, Overlapping Streams of Which Are Squirted Skyward in the Manner Apparent from the Illustration and Which Tests Have Shown to Act as an Efficient Mirror for the Purpose.

METALLIC MIRRORS NO BETTER THAN GLASS

Metallic parabolic mirrors were substituted for the more delicate glass types, but fared very little better at the hands of the enemy, who had become exceedingly skillful in quickly demolishing searchlight stations.

When this country entered into the conflict a new source of genius was brought to the assistance of the Allies, and among the most useful and much needed branches, the staffs of experts in the searchlight industries of several of the largest establishments in the world, were the first to whom was detailed the difficult problems of devising means to fill the requirements of



Photos Gilliams Service

A Floating Safe: An Ingenious Invention for Use Aboard Ships. The Safes Are All Equipt With a Complete Signal Apparatus Giving Light Every Fourth Minute. One Minute a Sound Signal (Horn) Every 9 Minutes, One Minute Duration, During 3 Months and a Rocket Every Hour During 12 Hours. The Signaling May Be Set to Commence One Half Hour After the Safe Floats. Every Safe Is Provided With Means by Which When Floating It May Easily Be Picked Up. It Also Has On It a Brass Plate On Which the Name of the Ship and the Cable Address of the Safe Company Is Stamped. It Is Also Thought That the Safes Will Prove of Value In Saving Life In Case of Ship Wreck, by Providing a Clear Beacon for the Lifeboats to Remain Close By, Thus Enabling the Rescuers to Find Them More Quickly.

Floating Safe For Ship Mail

OF the many recent inventions and devices recently invented to save life on high sea, all being more or less a direct result of the efficient, however ruthless, manner in which Germany carried on her undersea attack in the recent war, none has so far proved as practical as an ingenious invention known as a *Floating Safe* that has just been put into use by the Dutch Postal Service. This new device is being used on the mail steamers of the Netherlands Steamship Company, carrying mails to and from the East Indies and other parts of the world.

Because of its being a very efficient protector of valuable mail during the imperiling transit at sea, this new device is very likely to prove of most vital importance to the commerce of the entire world.

Great financial distress has often been caused as the result of important and highly valuable mail which it was impossible to duplicate, being lost following a wreck at sea. The loss at sea of valuable mail, containing drafts, checks, money orders, stocks and bonds, always results in serious delay in the straightening out and settling of affairs occasioned by their loss. There is not the least doubt that such accidents and losses have a retarding effect on international commerce along certain lines.

Considering all this, it is rather remarkable that no previous attempt of any account has been made to thoroly safeguard the mails in case of shipwreck. Now, however, that the thing has been done and a suitable device has been perfected by the Dutch Postal Service, it seems almost certain that other countries will follow the example of Holland, and that it will not be very long before all steamships carrying transatlantic mails will be equipt with floating safes built along similar lines.

The floating safe that the Dutch Postal Service is now using so successfully is very different in appearance from the ordinary combination safe such as we know it. Instead of being square, it is oval in shape, painted a glistening white, with the word "Safe" emblazoned in large letters on either side. These letters can be seen at a considerable distance.

The device itself consists of a safe proper and a cradle. The latter is made of a frame work of iron with stout wire netting. It will hold the safe under all circumstances, except when the ship with the deck on which the cradle is fastened sinks to a considerable depth below the water. In this case the safe is released automatically!

The safe during the voyage of the mail steamer is located on the deck of the ship in full view of the bridge, so that the officer on duty can constantly keep a watchful eye upon it, in the event that anyone on board the ship should attempt to break it open. As a further safeguard, it is connected with the dynamo of the vessel, so that any person not knowing the wiring and touching the outside will either start a signal or be unpleasantly surprised. At no time are passengers on the ship allowed near it, being warned constantly by the crew and printed orders to keep away from it.

The safe is oval in shape to prevent wreckage from attaching itself to it; also to give it greater strength and buoyancy. It is designed to float on the bulkhead principle, and the greatest of care is taken in its manufacture to prevent any possible leakage of sea water. In the manufacture no riveting is involved, all of the joints being welded and hammered. It is practically fireproof, being able to stand tremendous heat without melting or causing injury to the contents. It is constructed of three different sheets of especially prepared steel, each built inside the other, which add to it strength as well as buoyancy. While they are made in different sizes to suit the carrying capacity of the ship, most of the safes measure 4,000 millimeters (about 13 feet) in length, with a diameter of 2,000 millimeters (about 6½ feet), and a carrying capacity of 3,000 kilograms (about 3¼ tons), which is more than the average volume of really valuable mail shipt at one time on most transatlantic steamers.

At the time of a shipwreck, when the safe and its contents is cast adrift on the sea, it is by no means a helpless floating object, as on the top or deck of each safe there is a complete signaling apparatus, which, when the safe is thrown overboard and cast adrift from its cradle, starts to work automatically, thirty minutes after the safe starts to float. This apparatus flashes a bright light every fourth minute for the duration of a minute as a miniature lighthouse. In addition a signal horn is sounded every ninth minute. *These operations will be kept up for three months* should the safe not be picked up by that time. Besides these precautionary measures, hourly for twelve hours after the safe is released from the ship a rocket is automatically set off.

When the ship is about to leave port, the safe is closed with two or more covers provided with special locks and keys. Then it can only be opened by the use of a secret code. Every safe in addition is provided with a special compartment which automatically destroys all the contents should an attempt to force it be made by an unauthorized person.

In order that the Dutch public may profit by the use of the floating safes, special stamps (see photo herewith) have been issued by the Government. These stamps are now on sale at post-offices all over Holland, and when placed on a letter or package entitles it to be placed in the safe during the sea voyage.

The keys to the safe during the voyage are carried by the captain of the ship. On the payment of a small fee while at sea, passengers who desire to do so may entrust their valuables to the safety of the new device.

One-Man Car Versus The Jitney Bus

By L. H. ROSENBERG

AFTER the happenings at Toledo last fall when the city was without street car service for twenty-seven days, it will take something more than mere argument to convince the public that the auto bus will be able to replace the present street car systems in our largest cities. It did not take the citizens that length of time to determine that street cars were indispensable to their best comfort, and the only reason that service was not restored in a few days was due to a dead-lock in political circles. Altho numerous "jitneys" were imported into Toledo and private cars and motor trucks were utilized to transport the people during this time, the persons in the residential districts of the city found it well-nigh impossible to obtain means of getting to town without paying an exorbitant price.

In addition, the jitneys and auto buses increased the congestion in the downtown streets to an alarming extent. If this was the case when inadequate transportation facilities were available, it is not hard to visualize what the result would be if the number of automobiles was increased to take care of the situation.

Such a congestion is bound to increase the number of accidents because it is only natural to assume that the number of accidents varies as the number of machines on the street. Furthermore, the fact that auto buses have no definite lane of travel greatly increases the danger. Children playing in the streets (there is no other place to play in the large cities) are more than likely to stay off of the tracks where they are sure that cars will run with certain regularity. If, however, accidents do occur with street cars, the injured are certain to obtain some compensation because they deal with a responsible corporation. This is usually not the case with the auto bus or jitney because the owners are more or less of a fly-by-night character.

The general thought that auto buses take less time because they make fewer stops is not really correct, for this condition is not an advantage to the rider since auto buses are limited as to passenger capacity, and the reason that few stops are made is because they are loaded to capacity shortly after leaving their terminal. For instance, the Fifth Avenue buses in New York City, operating during the evening rush hours, run about two hundred feet apart, and they are usually filled to capacity shortly after leaving their starting place. Of course, if additional lines were placed in service, the situation would be somewhat relieved but any home-goer would rather stand up in a crowded street car than be delayed for his dinner.

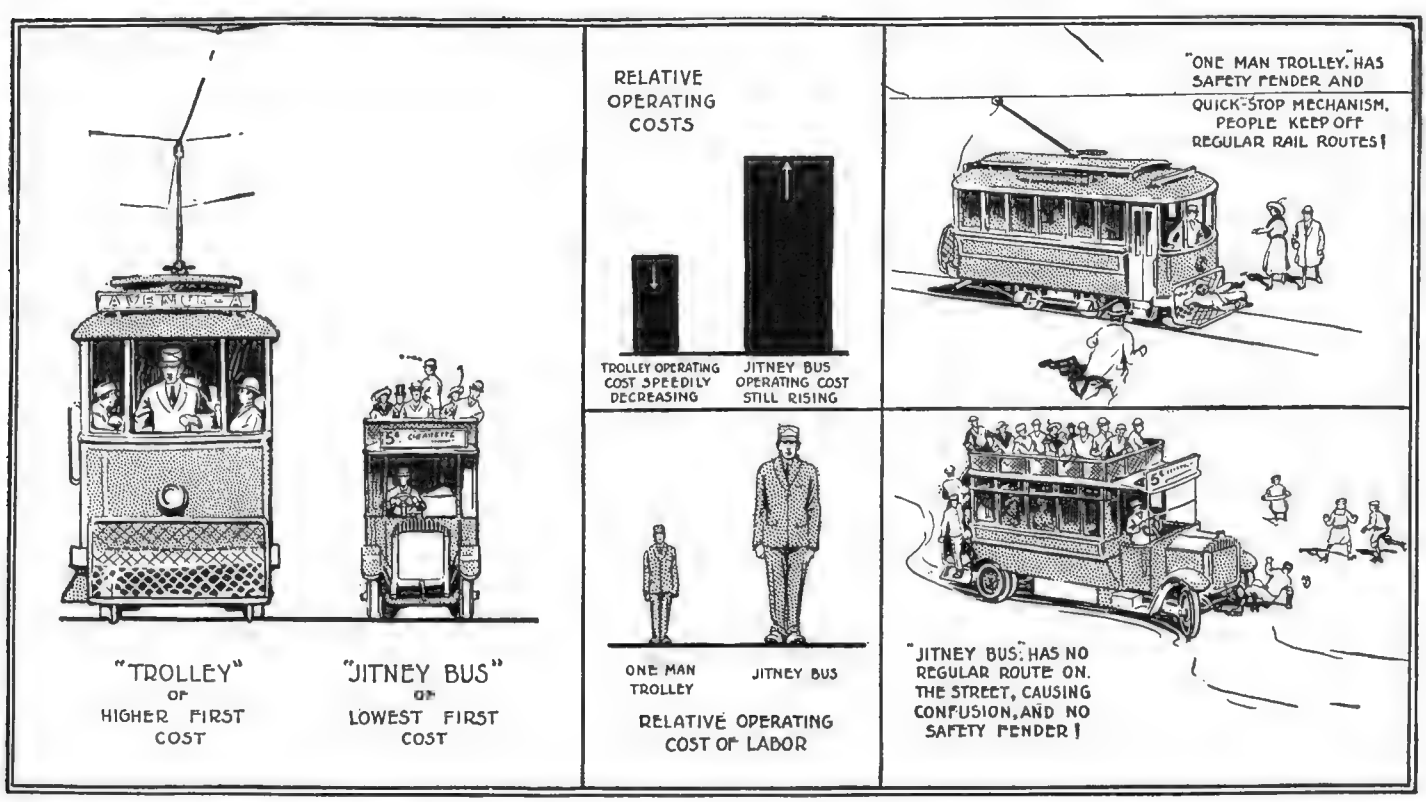
The possibility of auto buses replacing electric street cars has been still further lessened by the introduction in the last few years of the one-man safety car. About three hundred traction companies in the country have already installed these cars in order to reduce the headway between cars and to obtain increased operating speed. Since the cars are of smaller capacity, fewer stops are made, and they can operate at higher schedule speeds than the larger double truck cars. Their lighter weight permits a definite saving in power consumption.

Thus both of the so-called advantages for the auto bus frequency of operation and greater speed are equalled in the one-man safety car.

From the labor standpoint the safety car is comparable to the auto bus; in fact, it is better in some cases where two men are needed to operate the bus. More safety is obtained with the electric vehicle as adequate precautions are taken to make the safety features inherent in the design. Some of these features are: Car cannot be moved or the brakes released until the door is closed; the door cannot be opened until the brakes are applied and the controller moved to the "off" position, and the controller is equipt with a device which requires a conscious effort on the part of the operator to properly perform his various duties. These features actually prevent accidents.

After all the basis for determining which is better, the one-man car or the auto bus for transporting the people in large cities is the economical consideration. It is true that the first cost of the auto bus is less than the trolley installation when the entire investment of track, overhead, substations, etc., is considered, but the operating cost of the trolley installation is much less. This statement, of course, is based on the cost per passenger handled. With gasoline constantly rising in price there is no doubt but that this item is to become a greater and greater factor in the cost of auto bus operation. On the other hand, the cost of producing electrical energy is becoming less as large super-power stations are built. The water power bill just past by Congress guarantees that this cost will remain somewhere near its present value.

The apparent superiority of the auto bus is seen, therefore, to be really an inferiority, due to several factors, which are usually lost sight of by the layman.

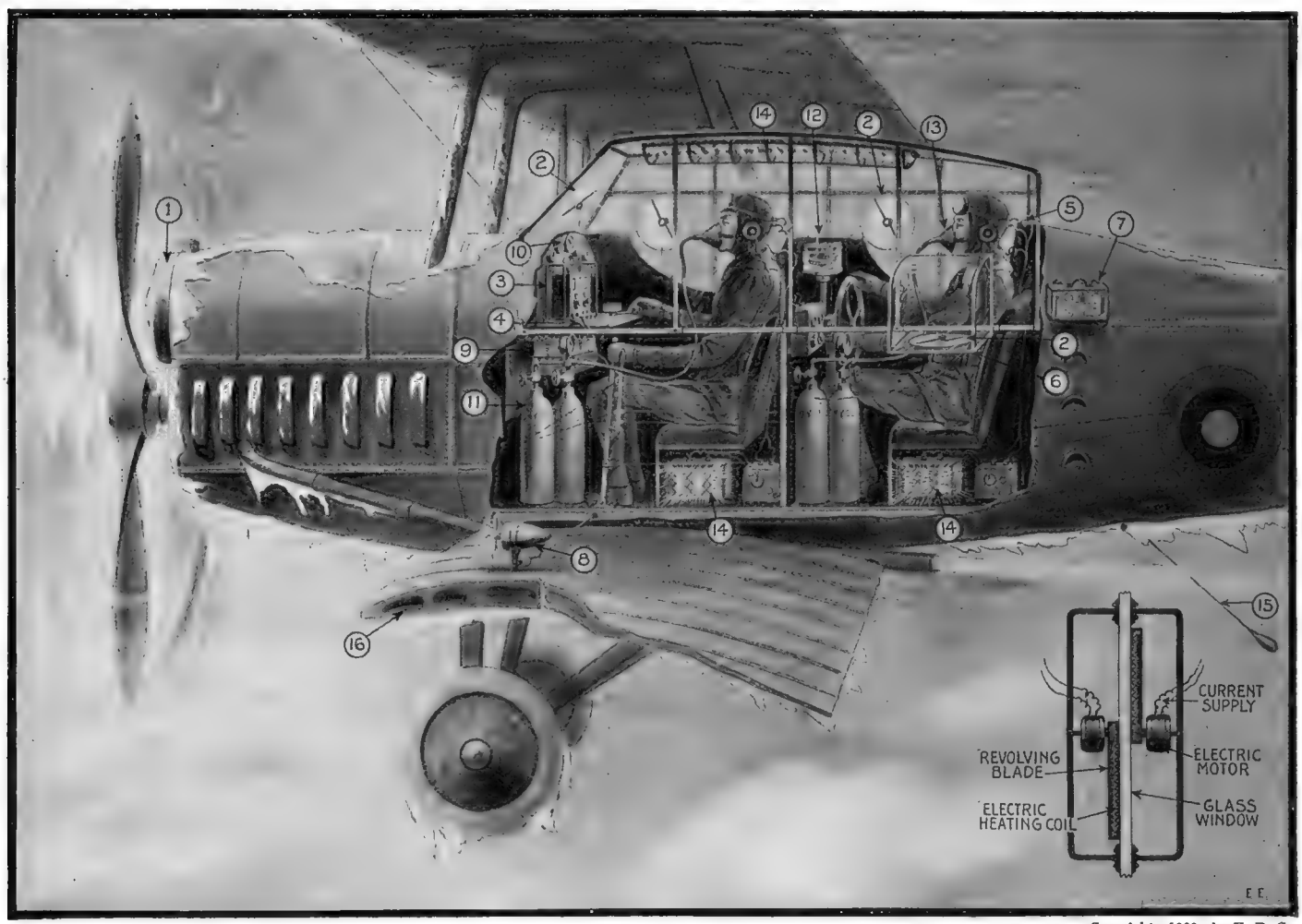

"TROLLEY" OR HIGHER FIRST COST
"JITNEY BUS" OR LOWEST FIRST COST
RELATIVE OPERATING COSTS
TROLLEY OPERATING COST SPEEDILY DECREASING
JITNEY BUS OPERATING COST STILL RISING
ONE MAN TROLLEY
JITNEY BUS
RELATIVE OPERATING COST OF LABOR
"ONE MAN TROLLEY" HAS SAFETY FENDER AND QUICK-STOP MECHANISM. PEOPLE KEEP OFF REGULAR RAIL ROUTES!
"JITNEY BUS" HAS NO REGULAR ROUTE ON THE STREET, CAUSING CONFUSION, AND NO SAFETY FENDER!

In View of the Numerous Articles Which Have Appeared In Various Enthusiastic Newspapers and Certain Journals Concerning the Wonderful Merits of the "Jitney Bus" as Compared to the "Electric Trolley," Our Readers Will No Doubt Like to Learn a Few Real Facts Concerning the Relative Values of the Trolley and the Bus as Analyzed by Mr. Rosenberg, an Engineer With the Westinghouse Electric and Manufacturing Company.

Flying In A Vacuum

What Happens to an Aviator Flying at 36,000 Feet Altitude and Higher

AVIATION fans have recently had reason to become greatly enthused over the marvelous high altitude climbed by Major Rudolph Schroeder, Air Service, U. S. A., when he forced his "La Pere" airplane, fitted with a 400 H. P. Liberty motor, to a height of 36,020 feet, smashing all world records in high flying, for any class of machine. Last year, Roland Rohlf set a new world's record in high altitude flights at 34,610 feet. Major Schroeder has kept persistently at it, and has now established his new record surpassing that of Rohlf's by 1,410 ft.



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1. Supercharger comprising Air Compressor and Oxygen Intensifier for carburetor System of the Liberty Motor, so as to Develop the Same Horse-Power at High Altitudes as at Sea Level.
2. Electrically Heated, Motor-Driven Ice and Water Scrapers on Glass Windows.
3. Wireless Telephone Transmitter and Receiving Set Mounted in Springs.
4. Wires From Radio Set to Microphone and Receivers in Helmet.
5. Electric Wires From Battery to Heating Coils in Helmet, Suit and Shoes.
6. Glass Window Electrically Cleaned for Looking Downward.
7. Barograph for Recording Altitude Automatically.
8. Wind-Driven Dynamo Supplying Electric Current for Radio Set.
9. Auxiliary High-Tension Battery for Radio Set.
10. Usual Flying Instruments,—Gasoline Gage, Etc.
11. Oxygen Tanks.
12. Gyroscopic Airplane Compass.
13. Oxygen Mouth-Piece, Including Microphone mounted therein.
14. Electric Heaters to Warm Glass-Enclosed Cab.
15. Radio Antenna Wire With Stream-Line Weight.
16. Section Thru Airplane wing.

Detail in Lower Righthand Corner, Shows Cross-Section of Electrically Heated and Driven Window Scraper.

Men today, especially aviators, are making history,—history more entrancing and exciting than the wildest tales of romanticism and adventure written by our greatest novelists. When Major Schroeder establisht his new world's record of 36,020 feet, at Dayton, Ohio, on February 27, he had one of the most miraculous adventures that any person possibly ever had or will have for some time to come. With his supply of oxygen low or nearly exhausted, his senses numbed by the severe cold of 67° below zero, his airplane covered with frost and ice, even to the red-hot exhaust pipe of the Liberty motor, and with his eyes partially frozen, Major Schroeder lost control of his machine and plunged earthward at terrific velocity. His plane fell like a plummet for a distance of 5 miles (his highest altitude having been nearly 7 miles; 5,280 feet per mile). The instruments on his machine indicated that it had fallen a distance of more than 5 miles in less than two minutes, that is, at the rate of one mile in .4 of a minute.

Having recovered his flying senses owing to his vast experience in piloting airplanes, at a distance of about 2,000 feet above the ground, Major Schroeder managed to get his machine out of the diving angle, and caused it to glide to a graceful landing. When the plane finally landed on the field, the spectators who had been watching it and who had thought that it was a comet or some other meteorological freak, rushed toward it and found the intrepid flyer sitting erect in the cock-pit, apparently lifeless. The terrific strain on the human body, especially the face and eyes, caused by riding thru the air at 100 miles per hour or more in a frigidly cold atmosphere, is here demonstrated vividly. On the surface of the earth it is generally understood, that the humors inside the eye-balls never freeze, but they apparently have a freezing point, and it would seem that Major Schroeder was so unfortunate as to have found it, for he landed with his eyes partially frozen, and spent several days under expert medical care in a hospital, before he was able to see properly.

Even before the rapidly falling airplane itself became visible, observers on the ground saw that which closely resembled the tail of a comet, which was caused by

(*Continued on page* 93)

Flashlighting Animals

By HOWARD TAYLOR MIDDLETON

PHOTOS BY THE AUTHOR.

THE little folks of wild life land (even those that travel by day) are often encountered in localities where the light conditions are very bad, and if the camera man would procure good pictures under these conditions it is essential that he resort to the *flashlight gun*. This little instrument, actuating on the principle of the toy cap pistol, and loaded with magnesium powder, will supply the necessary illumination to produce fully exposed negatives in a dark forest, either by day or by night.

Photograph of a "Grey Fox" Digging for Meat. Photographed with a Flashlight Gun By the Author and One of the Finest In His Collection. A Very Unusual Picture!

For our work Mrs. Middleton and I have found the "Imp" gun, costing a nominal sum, the most practical, as it works synchronously with the camera shutter, but the Eastman flash pistol, or an ordinary cap pistol, will suffice, as they can be synchronized with the camera by careful adjustment.

I think it very likely that the average person who wishes to enter the fascinating field of Nature Photography by flashlight will prefer the apparatus which is already synchronized. Therefore, I will explain in detail how pictures may be procured by an ordinary hand camera working in unison with the "Imp" gun. As you will note from the rough sketch of the "Imp" in action, it is composed of a pan in which the flash cartridge is placed, of a hammer that comes in contact with the powder when the trigger is pulled, and of an air pump which sends a current of air, by way of a rubber hose, to the camera shutter—operating the same at the instant when the explosion of the magnesium powder occurs.

There is also an attachment upon the gun for operating a camera furnished with cable release. This being the case, it is quite possible to operate two cameras at one time in connection with the "Imp" gun, one equipt with rubber hose, the other with cable—thus doubling the opportunities for a picture.

Let us assume that the sunset is a flaming pageant in the western sky, and that the first of the evening stars are winking overhead. It is time for us to take our way forestward in quest of night portraits. As we are in a good game country buried beneath a heavy blanket of snow, we will look for the tracks of Reynard, Odoriferous Sammy, the skunk, and, perhaps, for the bloody circle inscribed with an "X" in the centre where an owl has not only made his "kill," but left us his autograph as well. Expecting to find these denizens of the woods, we are well supplied with bait to tempt our prospective sitters to our out-door studio. Patience is a necessary virtue.

This Shows the Simple Arrangement of "Imp" Flashlight Gun, and Camera Operated By Air Pump On Gun, Set to Photograph Animals Automatically By Flashlight.

Flashlight Photo of a "Crow", Caught In the Act of Eating Corn Fastened to a String.

First of all, we discover where a fox has been digging for mice beside a rotten log. We set up our camera and flash gun there, running a thread from the trigger of gun across the point in the snow where we have burried a delicious morsel of raw meat. Later in the night when Reynard catches a whiff upon the breeze which speaks of an appetizing meal in the vicinity, he will hurry to the banquet at his best lope. Digging frantically, his paws soon encounter the thread; the trigger of the gun releases the hammer which falls upon the powder. A great white light spreads out fanwise in front of Reynard, frightening him mightily. He yaps with terror and flees away thru the forest, leaving the feast behind him—but we have our first animal self-portrait.

Odoriferous Sammy is exceedingly fond of cheese, and, if a succulent piece is left upon the top of a stump in a neighborhood where Sammy abounds, he will be glad to present you with his portrait in return for the sumptuous repast.

A dead bird, used as bait, will eventually bring an owl to our studio, and, if Fate is kind, even that monarch of the night, the great *horned owl* may condescend to sit for us.

Guess Who This Is? Yep, Foiled Again! It's None Other Than "Br'er Skunk" Nibbling On Some Cheese Used As Bait and Flashlighting Himself.

A thread strung with corn and laid upon a fence post near a crow roost, will result in a self-portrait of Black Jim.

By way of finale, let me say that nature photography by flashlight is such good fun that it is my earnest wish to have the many readers who are "Camera Bugs" give it a trial. I will be only too glad to give all the aid in my power to those who ask for it.

There are many other ways of rigging up a camera to photograph animals. Those electrically inclined will find it quite simple to work out an arrangement whereby an electro-magnet or solenoid circuit is energized by battery current when the animal trips a thread connected to a switch or light spring contact.

An Exceptionally Clear and Remarkable Flashlight Photo of the "Great Horned Owl."

Newton's Less Popular Laws

By PROFESSOR JAMES S. STEVENS

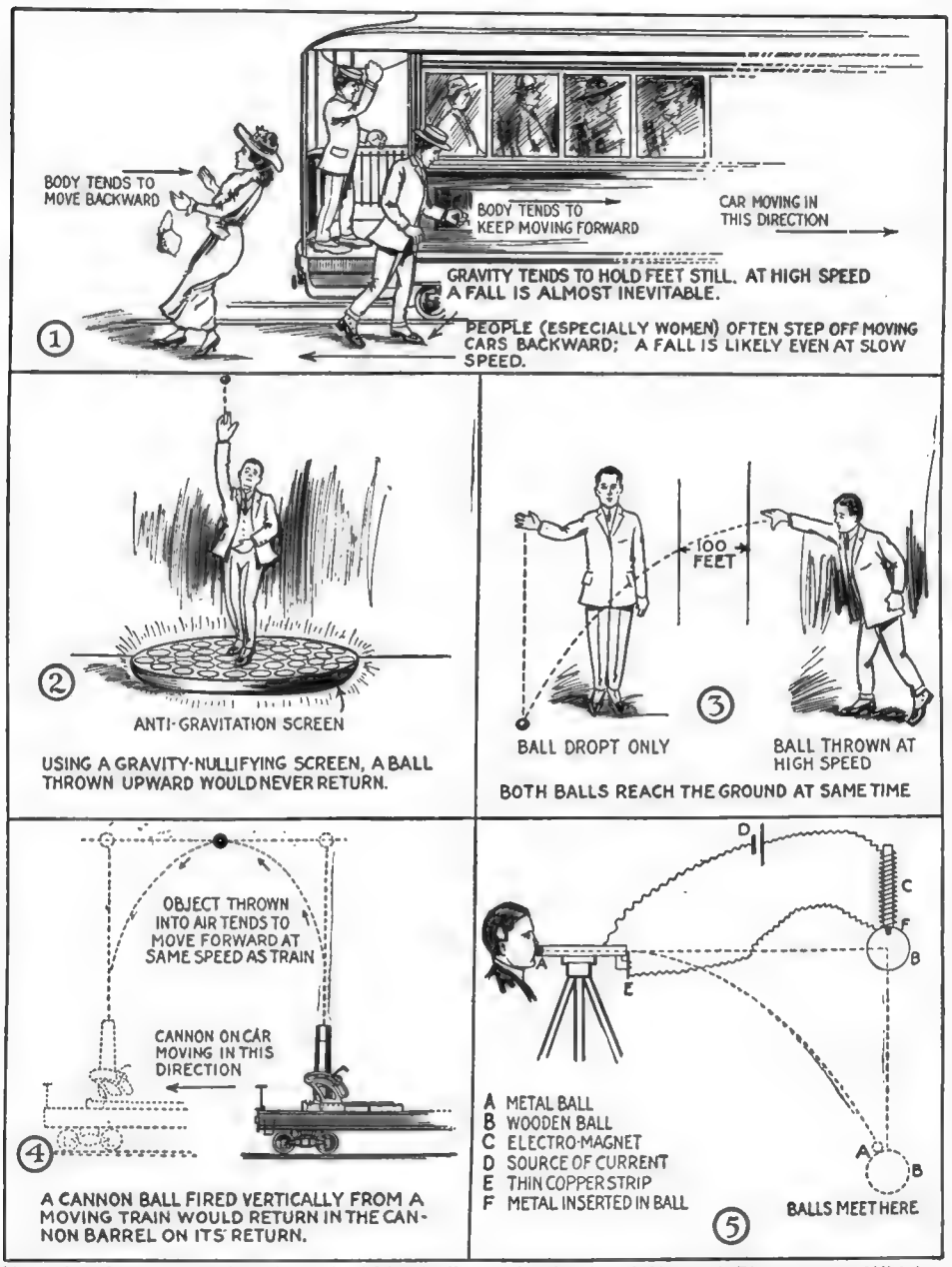
JUST now the great law of gravitation which was discovered by Sir Isaac Newton is very much in the limelight on account of certain proposed modifications which have been suggested by Einstein. We are in danger of forgetting that modern mechanics is very largely based upon three other laws laid down by Newton, called the *laws of motion.* These laws are, indeed, closely connected with the law of *universal gravitation,* and it is difficult to understand one without the other. Put in popular form these laws are as follows:

1. *If a body is in motion it will continue to move forever in a straight line, and if a body is at rest it will continue to be at rest forever, UNLESS some external force is applied to change these conditions.*

2. *If several forces act upon a body the resulting motion will be the same as if each force acted independently.*

3. *Action and reaction are equal in opposite directions.*

The first law is not capable of mathematical demonstration. Its truth appeals to our sense of fitness of things rather than to any experiment which has been made. The doctrine of relativity might, if completely understood, throw a light on the statement that a body tends to move forever in a straight line. On the other hand it completely destroys whatever lingering hope we may have had of being able to prove that a body at rest would rest forever.


BODY TENDS TO MOVE BACKWARD
BODY TENDS TO KEEP MOVING FORWARD
CAR MOVING IN THIS DIRECTION
GRAVITY TENDS TO HOLD FEET STILL. AT HIGH SPEED A FALL IS ALMOST INEVITABLE.
PEOPLE (ESPECIALLY WOMEN) OFTEN STEP OFF MOVING CARS BACKWARD; A FALL IS LIKELY EVEN AT SLOW SPEED.
1
ANTI-GRAVITATION SCREEN
2
USING A GRAVITY-NULLIFYING SCREEN, A BALL THROWN UPWARD WOULD NEVER RETURN.
100 FEET
BALL DROPT ONLY
BALL THROWN AT HIGH SPEED
3
BOTH BALLS REACH THE GROUND AT SAME TIME
OBJECT THROWN INTO AIR TENDS TO MOVE FORWARD AT SAME SPEED AS TRAIN
CANNON ON CAR MOVING IN THIS DIRECTION
4
A CANNON BALL FIRED VERTICALLY FROM A MOVING TRAIN WOULD RETURN IN THE CANNON BARREL ON ITS RETURN.
A METAL BALL
B WOODEN BALL
C ELECTRO-MAGNET
D SOURCE OF CURRENT
E THIN COPPER STRIP
F METAL INSERTED IN BALL
BALLS MEET HERE
5

Here Are Some Everyday Facts in "Physics"—or the Study of Natural Phenomena, Which You Probably Have Not Thought of. The Underlying Laws Are Clearly Explained by Prof. Stevens, So That You Can Readily Grasp the "Why and Wherefore" of These Seemingly Paradoxical Actions.

Certain rather interesting results follow from this law: It is due to this that a horseback rider is thrown headlong over a stone wall when the horse refuses to make the leap but stops abruptly when he reaches the wall. It is also due to this law that we fall down when alighting from a street car in motion if we are not careful. The motion of the car tends to cause us to move in a straight line in the direction of the car, while gravitation causes our feet to strike the ground and their motion is stopt while the motion of the upper part of the body continues. Hence the fall; see Fig. 1. It will be seen that the first and second laws act together, and the gravitation law has a part in the procedure. If it were not for the fact that gravitation acts constantly we would not reach the ground when getting off the car but remain traveling along beside the car at the same rate of speed. This first law of motion would make it impossible for a *gravitation screen* to be of much material advantage. If the rope of an elevator were to break and the gravitation were instantaneously screened off, the elevator would continue to fall due to the first law of motion. If we should toss a ball into the air we would never see it again if we made use of a gravitation screen; see Fig. 2. The same would be true with our own body if we gave a jump away from the earth. If we headed towards the moon and jumped at the rate of ten feet a second we would reach the moon in about four years. If, however, we had not taken the precaution to screen the gravitation effect of the moon we would land on the surface of the moon with the velocity of about two miles a second, which would doubtless render us incapacitated for lunar explorations.

The following illustration of Newton's second law will interest baseball fans. If a catcher had an arm sufficiently powerful so that he could throw a ball in a *perfectly* straight line from his hand to the foot of the second baseman, it would reach this point at exactly the same instant that a ball dropt directly downwards from the pitcher's hand would strike the ground; see Fig. 3. Strange as it may seem, a cannon ball fired vertically upward from the top of a train moving with constant speed *would fall into the mouth of the cannon on its return;* see Fig. 4. These illustrations, of course, take no account of certain modifications which might be made due to atmospheric friction, etc. A remarkably striking experimental illustration of the second law may be set up as follows: A metal tube about two feet long and three-fourths of an inch in diameter is clampt in a horizontal position in such a manner that upon looking thru it, we can exactly see the center of a croquet ball into which an iron screw or iron plug has been fastened, and this screw is held up by an electro-magnet as in the figure; see Fig. 5. A thin strip of copper touches the end of the tube and extends about a quarter of an inch above the bottom. An electric circuit is made including the tube, the copper strip, and the coils of the electro-magnet. When all is properly arranged we blow a metal ball thru the tube as swiftly as possible. When the ball strikes the copper strip the circuit is broken and the croquet ball begins to drop. Somewhere in mid-air the metal ball will strike the wooden ball. The experiment rarely fails to succeed if proper precautions are taken. The distance between the tube and the ball will depend upon the strength of the experimenter's lungs. Twenty feet is a distance which gives good results. The metal ball should be almost as large as the internal diameter of the tube in order that it may receive the entire force of the wind when it is blown thru.

There are few experimental illustrations of Newton's third law which are at all striking. It may be questioned whether in its net results this law is a benefit to humanity or otherwise. If it were not for this law we could bump our heads against a stone wall with perfect safety if we were

(*Continued on page* 106)

Electricity Gone To The Dogs

THE very latest in "Dog-land" is the canine clinic recently established for these intelligent quadrupeds in Berlin, Germany. The laboratory in which the clinic is located, is fully equipt with the most up-to-date technical apparatus for the cure and treatment of diseases peculiar to the canine. The photographs herewith, show the *artificial sun* treatment, comprising a powerful electric light in a highly polished reflector, and also a specially devised electrical *hot-air* apparatus.

One photo shows a sick dog being treated with what is known as the artificial *high-sun* rays, and it will be noted that the dog's eyes are covered with a bandage, so as not to injure them by the extreme brightness of the light rays here brought into play.

One of the most troublesome and frequent ailments of dogs in general, is skin disease, and the second photo shows a noble canine suffering from this affliction, being treated with the electrically heated hot-air applicator, to remedy this ailment. At this dog clinic, all kinds of operations are performed on dogs, for broken bones, nasal, throat and mouth troubles, et cetera. Many ailments among animals, and particularly in dogs, are of a rheumatic or similar nature, and often yield to intensified heat treatment such as that produced by the artificial high-sun device shown, or else by placing damp cloths over the injured member or over the entire body, and then placing the "patient" into a special electrically heated oven. These ovens have been developed very remarkably both in this country and abroad, and have proven their worth many times over, especially for cases of stiffened muscles, whether caused by direct injury, or from rheumatism. The temperature of these electrical baking heaters often reach a point as high as 400° Fah. This, of course, must be a perfectly dry heat, and the injured animal is carefully and tightly wrapt in dampened cloths, before it is placed in the treatment oven. This dampness soon dries out, and thereafter a steady dry heat is applied for a half hour or so, until the temperature rises to a considerable height, and in doing so, develops an extreme penetrating power which reaches to the bone itself.

At Left: Dog Receiving Treatment from Artificial Electric Sun in New Dog Hospital in Berlin, Germany.

At Right: Here We See a Faithful Canine Being Treated with Electrically Heated Hot Air for Scalp Ailments.

X-Rays Of Unprecedented Hardness

By DR. ALFRED GRADENWITZ

EVER since the gamma-rays of radium were shown to be essentially of the same nature as X-rays, the only difference so far being their greater hardness or penetrative power (or in other words, their shorter wavelengths), the attention of physicists and practitioners alike has been engrost by the problem of how X-rays of sufficient hardness to exert the same therapeutical effects as radium, how "artificial radium rays," as it were, could be produced.

Inasmuch as the hardness of X-rays is the greater, as the cathode rays by the stopping of which they are produced move with higher velocity—that is to say, as the voltage applied to the X-ray tube is higher, the solution of the problem from the very outset was sought in an unceasing increase of this voltage. A considerable advance toward the final goal was made by the invention of different types of glow cathodes allowing the electrons generated on the

(*Continued on page* 112)

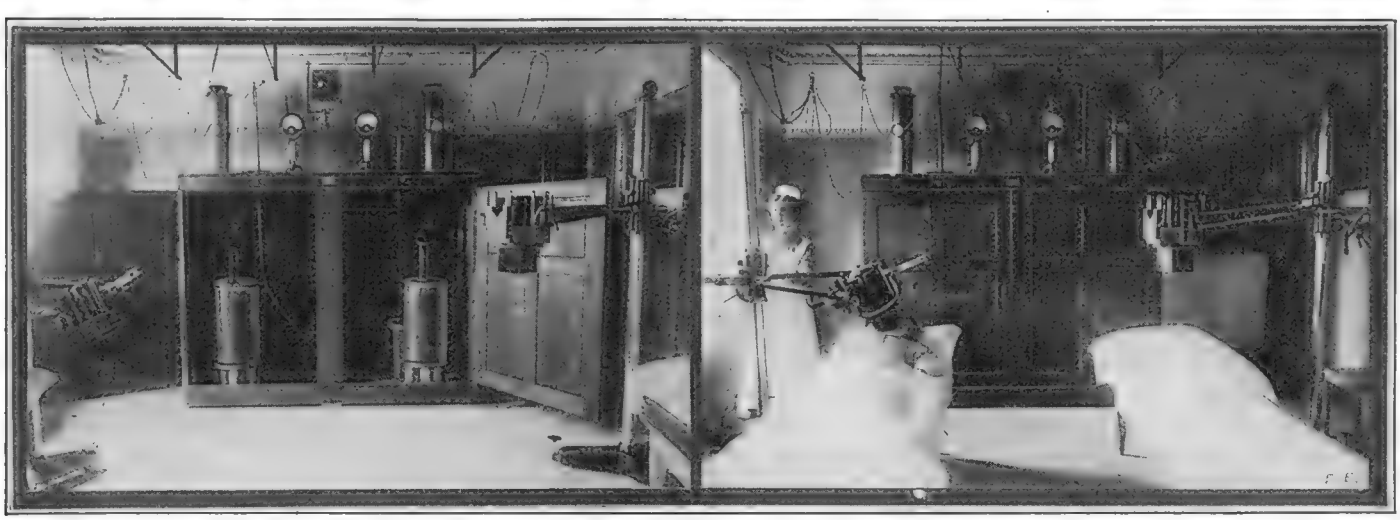


Photo at Left Shows the Ultra-High Potential Transformers and Cabinet with X-ray Tube Holders in Foreground, for Producing Extremely Hard X-rays Which, It Is Believed, Will Replace "Radium."

View at Right Shows Patient Being Treated by Extra Hard X-rays for Therapeutic Treatment. Potentials of Several Hundred Thousand Volts Have Been Successfully Used in This Special Work by Dr. Dessauer, of Frankfort-on-Main.

The "Lodestone" or Natural Magnet

By EUGENE S. TODD, Mineralogist

The First Law of Magnetism Is That Like Poles Repel, and Unlike Poles Attract. When Two Lodestones Are Held Side by Side in This Manner, the Iron Filings Link Across Between the North and South Poles at the Top and Bottom, Illustrating "Marriage."

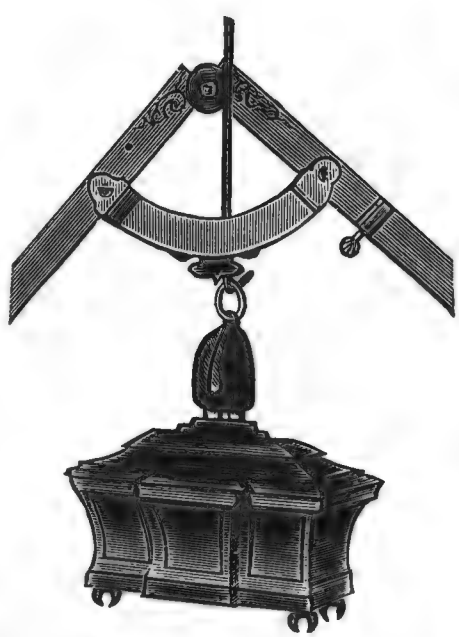
The Fact That "Like Poles" Repel, Is Here Clearly Demonstrated. When the Two North Poles and Two South Poles of a Pair of Lodestones Face Each Other, the Iron Filings Are Repelled, and Illustrate "Divorce," to Quote Mr. Todd.

I WANT to show you the "Lodestone"—perhaps you have never seen one, or even heard of one,—and yet it is the most wonderful stone in the world, barring none, and altho it is called a *stone,* it really is not one, but rather belongs to the family of minerals.

Why its name? Let me tell you. Suspended, by a silken thread or floated on mercury or on a circular raft on water, the same end of the stone will always point to the "Lodestar," Pole Star, Polaris, or North Star, as we know it; thus it will be seen that the lodestone is a natural compass, such as the Vikings used to make centuries ago, long before America was discovered, or before the compass as we know it today, was invented. Now after making a compass out of a lodestone, let us make one *with* the lodestone, as the Chinese did years ago, by rubbing a steel sewing needle over a lodestone to *magnetize* it, and then placing the needle very gently on the surface of a bowl of water. The needle, so placed, will float and immediately take a position pointing north and south. When the needle is floating on the surface of the water, the lodestone placed near it on the outside of the glass or bowl, will deflect it, turning it east or west, or for that matter, any way. Released from the influence of the stone, the needle will immediately resume its former position, pointing north and south. If the needle is a good one, you can draw it to the bottom of the glass of water, thus sinking the needle, and draw it up again to the surface of the water without once touching the needle, the lodestone being held flat against the outside of the glass, while moving it upward.

You can also make a compass out of a *steel pen* in the same manner, being careful to rub the south pole toward the point of the pen if you want it to point north, and the north pole toward the point, if you wish to make a south pointing compass as the Chinese do.

The mercury compass is more expensive to make, owing to the high cost of mercury, but it's well worth the price just to see the lodestone floating on its surface; floating, because the lodestone is so much lighter in weight than the mercury it displaces, the specific gravity of the mercury being 1357, and that of the lodestone about 783. In the mercury compass, it is well to paint or mark the north-pointing end of the stone, red or white, leaving the south pointing end, black or the natural color of the lodestone.



This Is Galileo's Original Lodestone, One of the Most Interesting Exhibits in the World, Especially to All Electricians. This Stone, After 300 Years, Holds as firmly as Ever, Its Suspended Weight of 15 Lbs., the Weight of the Stone Being but Six Ounces. This Precious and Historical Lodestone Is Exhibited in the Tribuna de Galileo, Florence, Italy. The Iron Weight Suspended at the Bottom of the Lodestone Is Made In the Form of a Sepulchre.

USES OF THE LODESTONE.

The lodestone is used in colleges in elementary classes, to demonstrate magnetic laws, and is used in preference to the bar or horse-shoe magnet because of its *permanence* and power,—for a good lodestone is more powerful than the average magnet of similar weight.

Lodestones are also used in automobile and aviation schools in demonstrating the principle of the magneto; by amateur experimenters in wireless; and is frequently taken home by parents as a useful and fascinating toy for children. It is a permanent magnet, and its magnetism can only be destroyed by heating the stone "red-hot." Altho the magnetism can be drawn out electrically and restored electrically, once the lodestone is heated as aforementioned, its magnetic life is gone beyond resurrection.

SUPERSTITIONS OF THE LODESTONE.

There are many superstitions about the lodestone, and it is believed by many people that these mysterious stones are always lucky, inasmuch as they attract the good and repel the evil. The circus people were wont to take them south during trips and sell them to the negroes at fabulous prices, and some of our most famous actors and actresses carry them. Paderewski, the great pianist, took one with him to Poland about three years ago, when he went there in the interest of his people.

The writer knows personally, a very celebrated actress, who absolutely refuses to go on the stage, without a lodestone somewhere on her person. She claims when she happens to leave it at home, something unpleasant is sure to occur, and when she has it with her, things run along smoothly. She says that *it makes her more magnetic,* and that she controls her audience with more ease, thus receiving more applause which incidentally increases her salary!!

There is an old saying in Sweden, (where the lodestone is found), "Wear a lodestone over your heart and it will insure you heart's desire; place it under your pillow at night, and your dreams will come true."

This Photo Shows the Jewelled Bearing Magnet Compass and One of the Earliest Forms of a Compass, Formed of a Piece of Magnetized Steel Resting on the Surface of a Glass of Water. A Steel Needle Was Magnetized by a Lodestone and Dropt Gently Into the Water in Early Times, but in This Case a Steel Writing Pen Was Employed. Try the Needle Trick Yourself. We Found It Most Interesting. It Points to the North.

This latter condition may not always be desirable, especially in cases of nightmare.

It is also a betrothal stone. A young man will break a lodestone in two pieces and give his sweetheart half, so that they will always be drawn together by the magnetism of the stone. In fact you can show the *marriage* of a pair of lodestones, viz: when they are drawn together,—but you can also show the *divorce* of the pair, and this occurs when they repel each other, as they undoubtedly will when like poles are placed opposite. You see a lodestone has two poles, one North and the other South; positive and negative, or male and female. Naturally the male end of one stone will only attract the female end of the other, which is called the "marriage of the stones," or the divine magnetic attraction between opposite sexes and unlike poles.

LEGENDS OF THE LODESTONE.

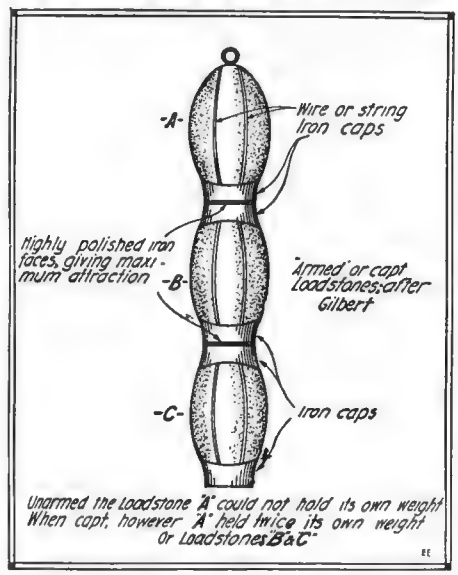
The stone is supposed to impart magnetism to the person carrying one, and many people believe they have been cured of rheumatism by keeping one about their person. Probably marbles would work as well!

Many strange stories of the wonders of the lodestone are told, one of these stories being of the mythical "lodestone mountain," described in "The Arabian Knights," the vessel being drawn toward it, until when quite near, all the spikes and nails were drawn from the ship, and she fell apart,—a total wreck, all the metal (iron or steel) parts of the ship flying towards the mountain, and the ship itself sinking to the bottom.

In Sweden (the most powerful lodestones and those here pictured came from Sweden), they tell how hunters have been unable to pick their guns from the ground, after laying them down near lodestones. They also tell of cases where the person's shoes had to be removed, owing to the nails in their soles, which held them fast. Of course these are only fables, the truth of which I shall not warrant.

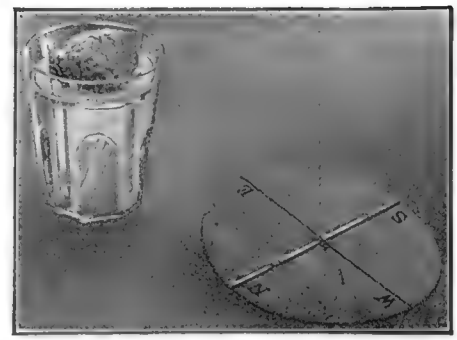
From history we learn about this most mysterious stone, how Mahomet's casket was suspended in mid-air by an immense lodestone, hidden from the view of the faithful.

Plato speaks of magnetic virtue divine. Marco Polo brought the idea of the mariner's compass from China. King Solomon used the stone to guide his mariners when searching for West Indian gold. Sebastian Cabot writes of variation of the needle, or magnetic deviation. Vincenzio Viviani, himself a distinguished mathematician, liked to be known as the last disciple of Galileo and tells us in a biography of his great master, that towards the close of the year 1604, he had completed a long study of the properties of the lodestone, and after


-A-
Wire or string
Iron caps
Highly polished iron faces, giving maximum attraction
-B-
Armed or capt Loadstones after Gilbert
-C-
Iron caps
Unarmed the Loadstone "A" could not hold its own weight When capt. however "A" held twice its own weight Or Loadstones "B & C"

This Diagram Shows an "Armed" Lodestone or Natural Magnet. When the Magnets Are Armed or Capt With Iron Pole-Pieces in the Manner Shown, Their Lifting Power Is Greatly Intensified, Even Doubled and Trebled.

many and varied experiments, had found a sure way of mounting any given stone so as to make it sustain the weight of iron,



Here We Have the Original Chinese Compass Formed by a Lodestone Floating on Mercury, at the Left. The North-Seeking Pole of the Lodestone, Which Is the Actual South Pole of the Magnet, Is Indicated by the Chalk Mark. Another Form of Compass, Comprising a Magnetized Steel Needle Mounted on a Circular Disc of Wood and Suspended by a Thread, Is Shown at the Right.

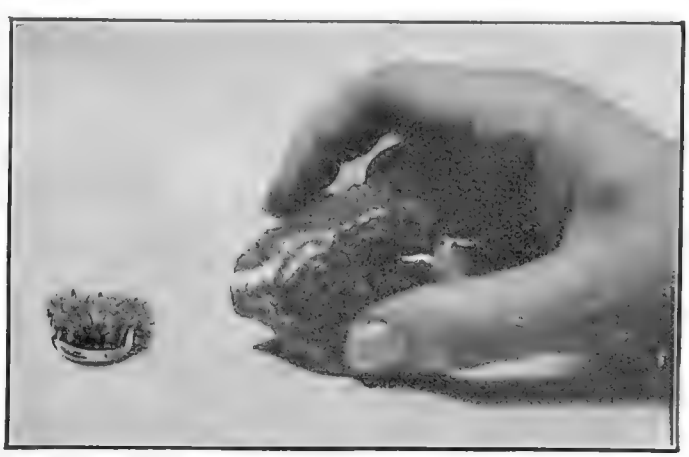
80 to 100 times greater than could be supported by the stone unmounted,—a result which had not been discovered by any other investigators up to that time, nor for that matter today—if you exclude electro-magnets.

It appears that during the long summer vacation at Padua, Galileo used to spend his vacation in Florence, where from about 1601 he gave private lessons in science, to the young Prince Cosino de Medici; in the summer he had evidently been rehearsing the wonderful properties of the lodestone, and having inspired his pupil with a keen desire to have one, he on returning to Padua, was able to send the prince a specimen, which he had obtained in Venice, and which weighed about one-half pound. It was not elegant in form, but was very powerful. A friend of his, Sagredo by name, had another fine stone which was beautifully formed, and weighed about five pounds,—and when it was known that Sagredo was disposed to part with it for a price of 400 scudi (about $450.00), the prince desired to obtain possession of this stone, but thought the price excessive. Thereupon, ensued a long haggling correspondence, which ultimately resulted in the prince purchasing it for 100 doubloons or about 100 guineas.

Unfortunately, the Sagredo stone was lost in after years, (also apparently the smaller one from Venice), and neither of them could be found after a careful and thoro search made by the request of Leibnitz in Florence, in 1698.

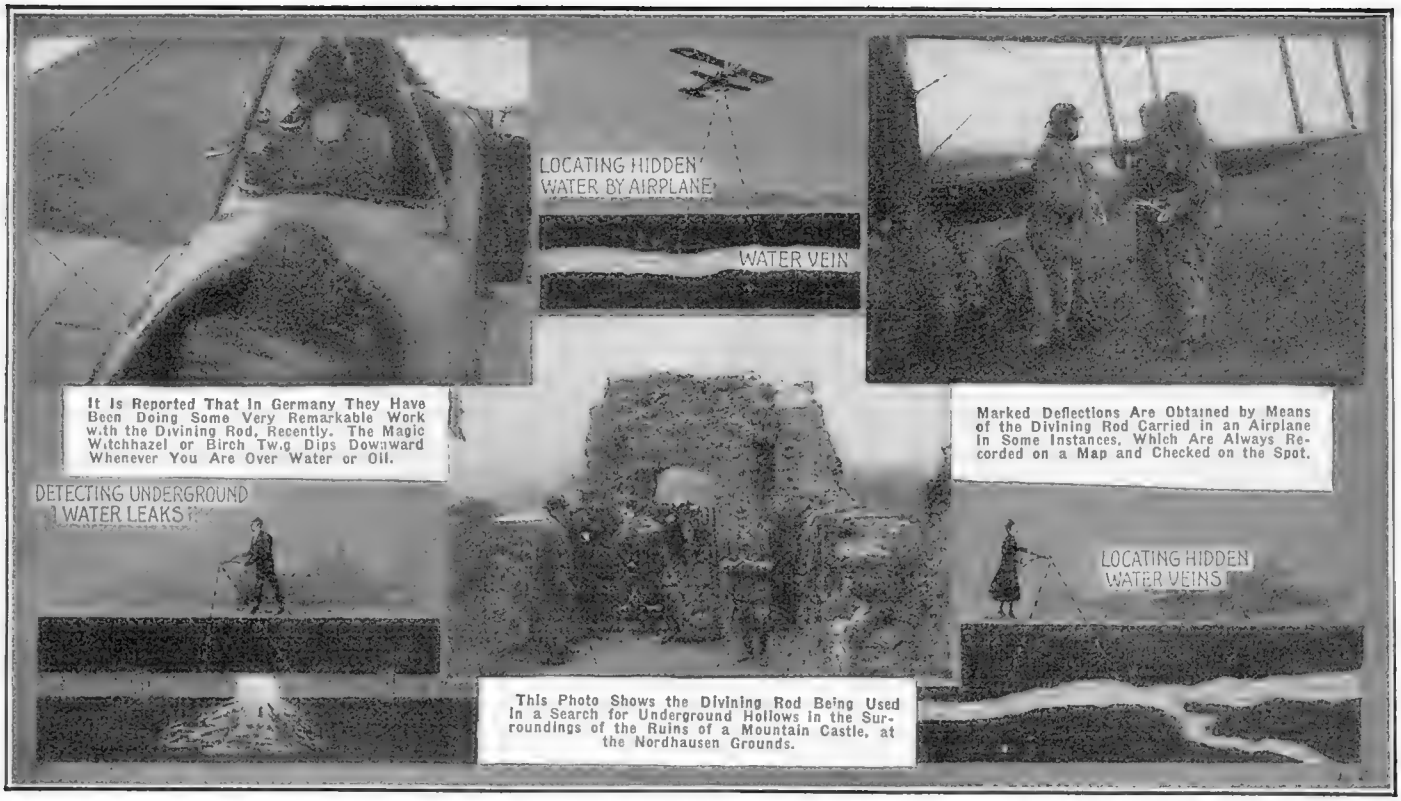
Dr. Gilbert in his book "De Magnete" publisht in 1600, speaks of a stone (whose weight is not known) which normally could

(*Continued on page* 88)



To Illustrate the Underlying Action of the Electric Motor, Two Lodestones May Be Used in the Manner Shown, the Smaller Lodestone Being Placed on a Polarized Steel Dome, Such as Those Placed on Chair Feet.

By Alternately Approaching the Opposite Poles of the Small Lodestone With the North and South Poles of the Large Lodestone Held in the Fingers, the Smaller Stone Can Be Caused to Rotate Continuously, the Same as an Armature of a Motor. A Small Steel Nail-File Was First Magnetized by Means of a Small Lodestone and Then Placed on a Polished Steel Dome, Such as Used on Chair Feet. By Alternately Projecting North and South Poles of a Large Lodestone Held in the Fingers Toward the North and South Ends of the File, It Can Be Caused to Rotate.


LOCATING HIDDEN WATER BY AIRPLANE
WATER VEIN
It Is Reported That In Germany They Have Been Doing Some Very Remarkable Work with the Divining Rod, Recently. The Magic Witchhazel or Birch Twig Dips Downward Whenever You Are Over Water or Oil.
Marked Deflections Are Obtained by Means of the Divining Rod Carried in an Airplane in Some Instances, Which Are Always Recorded on a Map and Checked on the Spot.
DETECTING UNDERGROUND WATER LEAKS
LOCATING HIDDEN WATER VEINS
This Photo Shows the Divining Rod Being Used In a Search for Underground Hollows in the Surroundings of the Ruins of a Mountain Castle, at the Nordhausen Grounds.

Airmen And The Divining Rod

By DR. ALFRED GRADENWITZ

The *divining rod* at present claims unusual interest from a double point of view: On the one hand, a scientific explanation of the enigmatical phenomenon is sought, that a forked twig or wire loop in the hand of a person specially gifted will deflect on passing over running water; on the other hand, endeavors are made to utilize this phenomenon for practical purposes, the more so as the puzzling rod has recently been found not only to deflect over natural, but as well over artificial water courses, especially piping. The Municipal Water Works of Munich, Germany, have, for instance, obtained some most remarkable results in locating pipe ruptures. Tests have also been made repeatedly in connection with ore, salts and coal layers. In the present critical situation due to Germany's having had to give up some of her most valuable ore and coal mines, special hopes are in the Fatherland attached to the help of the *divining rod.*

At the recent Congress of the *Association for Elucidating the Divining Rod Problem,* held at Nordhausen, there were discust these possibilities of application. Another new development dealt with was the possibility of using the divining rod from an airplane. A well-known divining rod specialist, Otto Edler von Graeve, gave a practical demonstration of the way underground water courses are ascertained from the airplane, the deflections of the divining rod being afterwards recorded on a map and checked on the spot.

Phono-Clock Wakes You Gently!

Undoubtedly you have heard the story of how to be awakened gently, by nothing less than the sweet music of a string orchestra or the tinkling chimes of Westminster Abbey, in the distance, so specifieth those who know.

Well, friends, here it is at last, and all you need is an alarm clock and a phonograph—puts us in mind of the chap who bought an automobile cap and all he needed then to complete his outfit was an automobile! But this is not as comical or tragical as it might at first seem. In all seriousness we have tried this stunt, and it works to perfection, and all that we have to say in the line of criticism of this interesting and much desired invention is that the world is looking for the "genius" who can put up this combination on a nice little wooden base and sell it for a dollar or two.

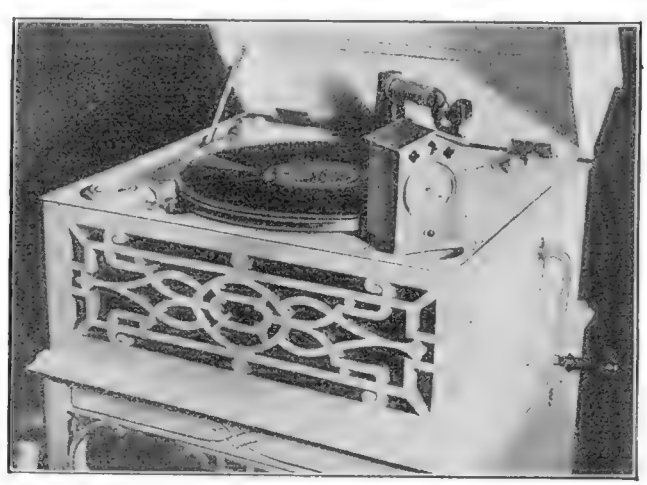
We remember a chap who worked night and day on such a contrivance, comprising a little three-inch home-made phonograph disc record, with a "get-up" message suitably inscribed on it, all of which can be fitted to a small shaft protruding thru the top of the alarm clock, and then connected with the alarm spring mechanism within the clock. It worked!

We have often wondered why some one did not think of this idea and develop it to a logical commercial conclusion, which could be on the order of the "talking doll" which has a small, cheap phonograph fitted within it. It seems a capital idea.

In the illustration here shown, the alarm clock rests on the phonograph cabinet and when the alarm rings in the morning, it releases the turn-table brake and before you know it, you are slowly coming back from Slumberland to the tune of the "Anvil Chorus" from *Il Travatore,* if you have a strong mind, or to the lilting strains of the "Merry Widow Waltz," if you are temperamental.

Or if you are one of those hard sleeping hounds, put on "Shimmy With Me."

So we may look forward to the day not far distant when we can purchase at approximately the same sum we now spend for a "Big Ben" alarm clock, one of these new-fangled "do-funny" phono-clocks. Possibly some long-whiskered psychologist or student of mental phenomena may devise a form of music which will serve not to awaken you, but to put you to sleep! When you stop to think about it, you probably will recollect that at the last musicale you attended some of the dreamy selections caused your mind to relax to such a degree that you presently found yourself wandering on the borders of Slumberland.



Set the Clock at Your Arising Hour—the Phonograph Does the Rest!

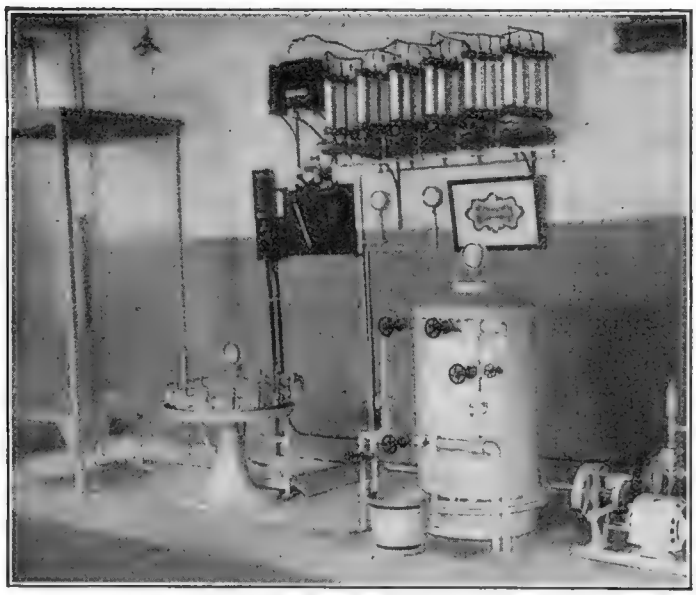
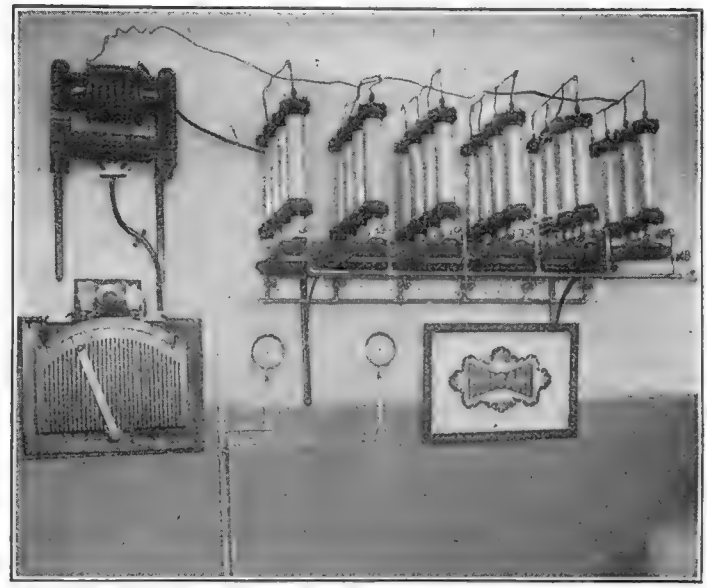


Photo Above Shows the Newest Thing in Electric Water Purifiers, Which is In Daily Use In New York City. It Represents One of the Most Elaborate Filtering and Electric Ozonizing Water Plants Ever Devised.



This Photo Shows a Close-up View of the High Potential Electric Ozonizing Tubes In Which Free Ozone is Liberated, and Eventually Caused to Pass Thru the Water and Destroy All Bacterial or Other Germs In It.

New York Has Ozonized Drinking Water

By Joseph H. Kraus

OZONE as a germicide and deodorant has been dealt with so many times that it is scarcely necessary for us to mention in detail what its action is. All harmful germs and growths in water are positively annihilated when water is purified by ozone. After ozonization it is 100 per cent free from disease germs and at the same time produces a very sparkling drink.

An enterprising New York concern, after having worked for years on the problem, has evolved not only a system of providing and filtering water, but has also obtained patents on an improved form of silent discharge ozone generator. Essentially, ozone consists of three atoms of oxygen bound together in the form of one molecule. It is produced by pumping air thru these silent discharge tubes between the electrodes, the oxygen of which is made to combine by the action of a high frequency current. Thus the oxygen comes into a nascent formation more active and powerful as an oxidizing agent than pure oxygen of the air.

The apparatus developed by this company first allows the water to filter thru a regular sand filter. The water then passes under 45 pounds of pressure thru a silk filter, and thence onward to a large glass tank. Before its entrance into the tank, however, it unites with the ozone supply pipe coming directly from the discharge tubes whence the ozone and water continue onward to a large glass chamber. Here they squirt out in the form of fine sprays of water, the ozone thoroly acting on every droplet. In this way ozone action is absolutely thoro, and not nearly as long a time of exposure is necessary as with the ordinary ozonating apparatus.

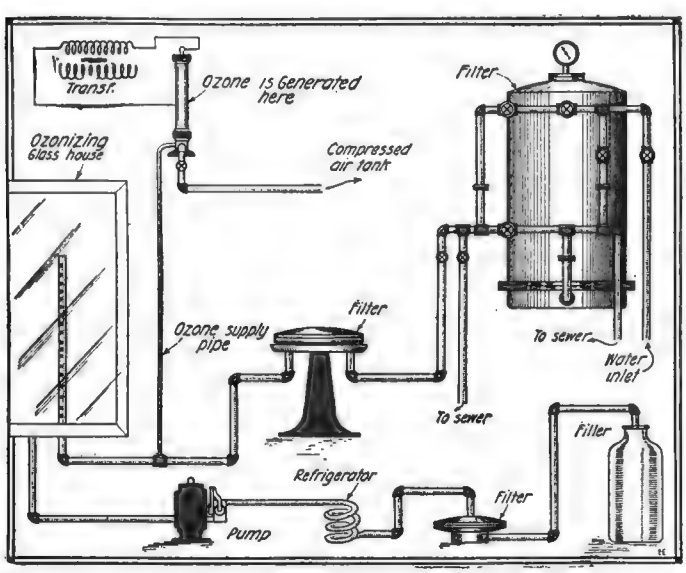
The ozonized water then passes into a refrigerator where it is cooled and goes onward to the final filter. From here it goes to the supply pipes and it is bottled according to the latest style—namely, in Thermos vacuum bottles. This company supplies the water daily in bottles of any size for office use. The water is always cold and sparkling, being tasteless at the same time. There can be no doubt as to its purity and utter absence of bacteria, as bacterial plate cultures prove negative.

The entire system is electrical; pumps, transformers, and in fact even delivery is carried on by the use of electric current.

The silent discharge chamber consists of two aluminum tubes fitted at the top and bottom to Bakelite ends made to fit these tubes accurately.

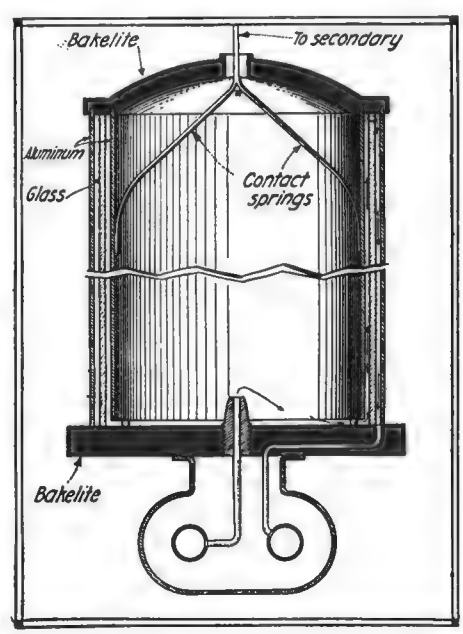
Separating the tubes is a thin-walled glass cylinder. The air passes thru a pipe from a compressor, travels thru the space between the glass center and inside aluminum chamber. Thence down between the glass and outside chamber and out again. During its passage the air is under continuous action by minute electric sparks, which cause its oxygen content to form into its very active state of O_3, or ozone.

Connection to a 15,000 volt transformer is effected by means of a spiderleg-like spring inserted into the top of the discharge chamber, making contact with its inner wall, while a connection also goes to the outer wall. Insulation is so perfect that the jars may be grasped while the apparatus is in operation without a shock being felt.—*Photos courtesy The Moissant Company.*



Left: Diagram Shows the Various Stages Thru Which the Water is Past Before It is Eventually Filled Into Vacuum Bottles, in Which It is Distributed Daily to People in All Parts of the City. The Water is Not Only Filtered and Ozonized, But It is Also Cooled By a Refrigerating Plant.

Right: A Detailed Diagram of One of the Ozonizing Tubes Shown in the Photos of the Complete Installation. The High Potential Electric Current is Connected to the Inner and Outer Aluminum Cylinders. This Causes An Electric Brush Discharge to Take Place Around and Thru the Glass, Thus Producing Ozone.



Church Service By Phone

Church Service Via Telephone Is One of the Latest Innovations, In the Realm of Applied Science. The Above Picture Shows the Microphone Mounted Just In Front of the Church Pulpit and Also the Sick Man With the Receiving Head Gear for Reproducing the Words of the Pastor, as Well as the Choral Music.

Mr. Sam Pritchard, a miner of Penycas, Ruabon, Wales, injured by the fall of a rock a year ago in a colliery, now hears church service regularly at the local Baptist Chapel by means of a telephone rigged up by three of his friends. One of the photos shows the injured man listening to the service going on at the chapel some distance away.

The second photograph shows a close-up view of the pulpit in the church, with the telephone microphone arranged so as to gather its quota of the preacher's vocal waves. This idea brings to mind a scheme which may be found useful in many diversified instances, i.e., this idea should prove a valuable one on Sundays when the weather is extremely inclement and when deep snows cover the country as in the northern and western part of the United States, so that the Sunday church service could be enjoyed just as well over the telephone, as not.

In the present instance, the apparatus required is not very expensive and comprises a simple telephone transmitter or microphone button, together with a few cells of dry battery, a sufficient length of twin conductor telephone wire and a telephone receiver, or two, of the 75 ohm watch case type, which are worn on a headband by the gentleman shown in the photograph.

Car Propelled By Air Screw

Owing to the great shortage of coal as fuel for trains in Germany, an inventor of that country has rigged up the unique air driven railroad car shown here. He has simply adopted a powerful type of airplane engine to one end of the railroad car, which altho it may not seem so efficient as a regular motor-driven car, resulted in a speed of 60 miles an hour.

The motors used on these German air-propelled cars are rated at 160 horsepower. The usual gasoline fuel tanks and cooling water radiators are seen mounted on the platform of the car, at the left.

This gives us another idea, viz., that as the Germans have a great many thousand airplane motors on hand which they have no use for just now, they will probably find quite an extensive field for their application to railway cars, etc.

This novelty would also seem to lend itself very well to the utilization of second rate engines or airplane engines which do not come up to the "top notch" test such as required by the rigid rules laid down by the aviator. If a second grade engine or one that is somewhat worn is adapted for this service on railway cars, no one will be injured if the engine should happen to misfire now and then,—while the aviator demands the very highest degree of efficiency in performance; and recent tests have shown that even the far-famed "Liberty Motor" is good for only 100 flying hours' service on an airplane. But it would undoubtedly be good for several hundred, or very possibly several thousand running hours, for such service as that here shown. The idea is worth trying.

How the Germans Have Found a Use for Thousands of Airplane Engines Which They Have on Their Hands. Also on Account of the Great Shortage of Coal in Germany, These Wind-Driven Cars Have Found Much Favor in the "Vaterland."

Electricity in the "Movie" Studio

By CARL M. HEINTZ

ELECTRICITY has played no little part in this great industry, working its way into every phase of the motion picture work. The principal use of electricity is in the stage lighting. In general stage lighting is a combination of what is called "hard" and "soft" light. The mercury vapor lamp, which is very largely used, possesses the actinic qualities that make it very excellent for this work. The mercury vapor lamp gives a soft light and in order to bring out the high lights in a picture or to emphasize contrasts in a picture, arc lights are employed. These arc lamps which throw off a "hard" light are very generously used and consume a considerable amount of current.

While the mercury vapor lamp is supplied for either A. C. or D. C. current, it is generally considered that its operation on D. C. is more satisfactory.

It is generally known that an arc lamp operates better on D. C. than A. C. or when operating on A. C. it changes its intensity of illumination slightly with every alternation, and since it is possible for this to synchronize with the shutter operating on the "movie" camera, one can readily see why D. C. is more satisfactory for stage lighting.

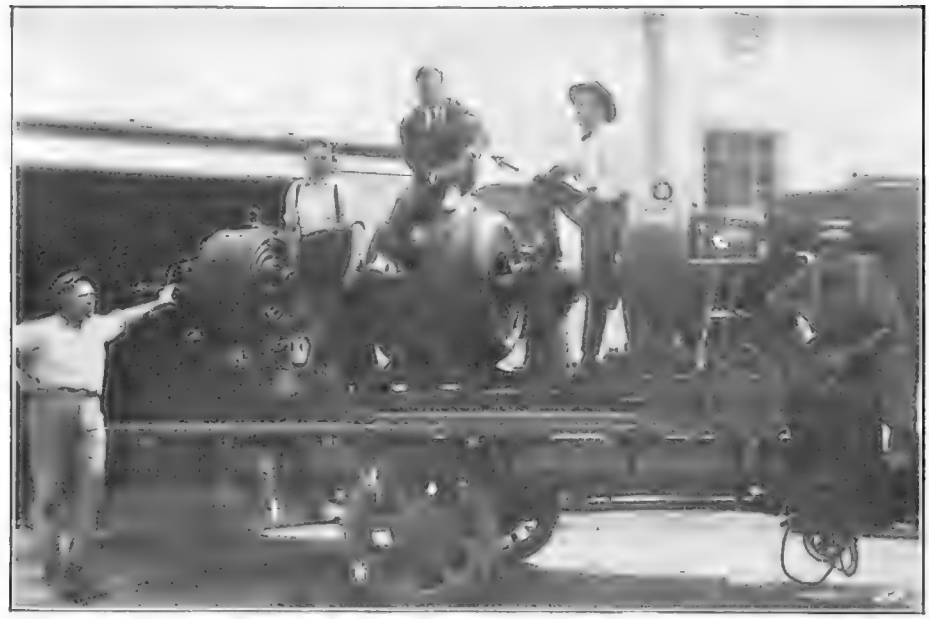
It might be interesting to briefly outline the electrical equipment at some of the studios. Take the *Metro Studio* for instance. The Southern California Edison Company's incoming high voltage line of 15,000 is stept down in a bank of 3-250 K. V. A. Transformers to 2,200 volts. They also have another bank of 3-100 K. V. A. Transformers stepping down from 2,200 volts to 110 volts 3 phase. These supply the stage-lighting circuits. The A. C. lights being mostly used for overhead lighting.

The Chief Electrician at this studio uses a very novel scheme to secure constant voltage regulation on his A. C. lighting circuits. It is most desirable to maintain a constant voltage regulation for two reasons, one that it produces better photography, the other it increases the life of the mercury vapor lamps.

The Metro Studio has installed a 3-phase, 60 K. V. A., 2,200-volt Induction Regulator, which controls the bank of 3-100 K. V. A. Transformers on the lighting circuits.

Then when the director calls for the lights and a very few seconds later calls for the camera to "shoot," the regulator has compensated for the additional load which amounts to a great deal on large settings. The voltage under this arrangement never varies over a volt and a half at the point of distribution. At this same studio the D. C. current for the stage lighting is supplied by a 300 K. W. Motor Generator Set.

Outside of using electricity for stage lighting the studios use a great deal in their carpenter shops, laboratories and projection rooms, etc.—*Photo Courtesy Westinghouse E. & M. Co.*



Of Course the Editors Couldn't Pass This Photo Up, With "Doug" Fairbanks Sitting On One of the New Motor-Generator Units For His Studio. It Is Hard To Determine Which Is the Most Alive, the Dynamo or "Doug," Especially When He Does Those Mexican Athlete's Stunts Down In "Sunny California."

Railroads are Electrifying

SINCE the United States has an abundance of coal, railroad electrification here has been determined solely by local conditions. Passenger terminal problems caused the electrification of the New York Central at New York and the Pennsylvania at New York and Philadelphia. The limitations of the steam locomotive determined the electrification of the Baltimore Tunnel on the Baltimore & Ohio, the Cascade Tunnel on the Great Northern, the St. Clair Tunnel on the Grand Trunk, the Hoosac Tunnel on the Boston & Maine (see photo herewith) and the Detroit River Tunnel on the Michigan Central. Examples of electrified railroads with freight as well as passenger service are the Norfolk & Western, the Chicago, Milwaukee & St. Paul and the New York, New Haven & Hartford.

The American Railroads Are Fast Awakening to the Fact That "Electrification" Means Dollars and Cents to Them, Altho It May At First Seem of Tremendous Initial Expense. Here We See a Boston and Maine R.R. Electric Locomotive and a Steam Locomotive.

While the other electrifications are successful and interesting, the last three are more properly representative of general railroad electrification. The Norfolk & Western is an example of electrification under the heaviest conditions of freight traffic on a mountain grade. The Chicago, Milwaukee & St. Paul has in operation the longest continuous mileage in the world, and when completed will cross five mountain ranges. The New York, New Haven & Hartford has a very large movement of both freight and passenger traffic. All three installations are successful and profitable, and when financial conditions are stabilized and the American railroad question settled, it is expected that all three will extend their electrified service.

Differing from America, European and South American countries, with the exception of England alone, lack an adequate supply of fuel, but many of them, including Norway, Sweden, Switzerland, Italy, Spain and Brazil, have large amounts of water power, while France has a moderate amount. These resources combined with the high cost of fuel make extensive railroad electrification in these countries inevitable sooner or later. *Photo W. E. & M. Co.*

New York Aero Show

THE second annual Aeronautical Show was held in New York City, at the 71st Regiment Armory, from March 6th to the 13th inclusive, under the auspices of the Manufacturers' Aircraft Association. Many new innovations and novelties of design were shown and brought out in the aircraft exhibit. In some and in fact in most cases, the larger and outstanding trend of design at the present time, is clearly along the lines of comfort and practically nothing of a military nature was exhibited at the show.

This is as it should be perhaps, for we have had enough war to last us for a while, and the airplane which people are today interested in, is quite naturally that which will carry them the most comfortably and the most safely from place to place. Airplanes as well as gas filled dirigible balloons were shown at the exhibition, and ranged in price from $2,500 to $15,000 and more.

The family aerial runabout known as the *Butterfly Sport*, has been developed to sell by the thousands just like *Fords*, for the flying public who have not the desire to invest more than $2,500, and yet who can obtain from this machine all of the thrills of flying, besides the advantages of rapid travel—for this little machine can skim thru the air at a 72-mile-an-hour clip, with a single passenger.

The Latest Addition to the Flying World is the "Butterfly Sport" Monoplane, Which Has Just Been Brought Out for Family Use at Popular Prices. The Makers Claim They Are Going to Turn Them Out by the Thousands, Just Like "Fords" and the Price is $2,500. They Have Got the "Flivver" Beat, However, when it Comes to Speed, for They Skim Thru the Air at 72 Miles an Hour and Better, With a Single Passenger. This Plane and Another Similar Plane at a Slightly Higher Price, Capable of Carrying Two Passengers, Were Exhibited at the Recent New York Aeronautical Show.

The United States Army and Navy exhibited at the show, but the regular commercial airplane manufacturers had the greatest number of devices and machines on exhibition.

ELECTRIC AIRPLANE NOVELTIES.

Electricity is finding its way into the realm of aeronautics more and more each year. While nothing startling was shown in electro-aeronautic developments at the show, one thing was noticeable, and that was that more planes than ever before are being fitted with *electric self-starters*. The Curtiss planes are invariably fitted with electric self-starters, and this is particularly noticeable in the seaplanes, which many readers have probably seen in actual flight at Atlantic City and other locations. Thanks to the electric self-starter and other features, the seaplane of this type rambles thru the air and up and down off the water, just like a regular *Ford* on land.

The seaplane has it on the land plane in that if you should happen to drop a few hundred feet and land in the water, the chances are you will not spoil your disposition very much, but if you take chances on landing inadvertently on a church spire or on some one's nice iron picket fence in the heart of a city, you ought to wear a barrel or two of shock absorbers in order to minimize the "kick" of the sudden stop; —as the Irishman remarked, "he didn't mind the going up, but it was the 'sudden stop' in coming down, that slightly jarred his nerves."

The famous *bubble-sextant* which had a great deal to do with the successful navigation of the famous N. C. planes in their flight across the Atlantic Ocean, was exhibited at the Navy booth and explained by naval officers, to the interested public. The bubble on this sextant is electrically lighted. There was also exhibited and explained by the naval officers, an improved form of rapid range-finder for aircraft.

It was noticeable at the show that aircraft builders are beginning to fit them out regularly with electric *tail* and *wing-tip* marker lamps, red and green, etc., and they are also developing tiny wind driven generators for supplying current to various navigating instruments, for operating the wireless set, (when carried on board), etc.

There are, of course, a host of other distinct electric novelties in the world of flying, which are not very common, such as electrically heated uniforms for high altitude flying, electric foot warmers, electric searchlights for landing at night, and, of course, the wireless telephone and telegraph, which have been developed considerably since the close of the war.

An interesting feature observed at one of the airplane radio exhibits, was an audion detector and amplifier cabinet, containing two bulbs, and the wooden cabinet of which was resiliently mounted on four strands of one-half inch diameter heavy rubber bands, stretched between the sides of a metal frame, so that no vibration whatever could reach the cabinet.

A radio *direction finder* with revolving loop antenna for use on planes, was also exhibited. By means of this apparatus, the aviator can quickly determine in what direction radio transmitting stations are located, and thus he will be able to quickly find his own bearings.

CANNON FIRES THRU SHAFT OF NEW ENGINE.

The Wright Aeronautical Corporation exhibited the powerful new "Wright-Hispano" airplane engine, fitted with a 37 mm., rapid fire cannon—get that!—cannon we said!—which fires a one-inch projectile directly thru the center of the hollow shaft of the engine. This spells *good-bye* to armed flying tanks such as those developed near the close of the war, by the Germans. To aim the gun, the aviator has to jockey the plane of course, until the axis of the machine and the engine are in direct line with the target or enemy plane. This beautifully built motor is also arranged to fire synchronously, two machine guns mounted on either side of the engine.

Many other interesting things aeronautical were exhibited. A new comer in the spark plug world was in the form of a mica plug, for which it was claimed that an original set of these were flown in a Martin bombing plane by Col. R. S. Hartz, in his "round-the-rim" flight of 9,823 miles along the entire border line of the United States. Very remarkable indeed, in view of the fact that not one of the plugs was removed during the entire trip from July 24th to November 13th.

An interesting gyroscopic *turn indicator* was demonstrated at the show, and this contained a white disc driven by an air-propelled gyroscope which tended to pop up before right or left hand windows, whenever the aviator attempted to make a turn. This was pointed out as a very valuable new instrument, as it is impossible for an aviator to tell from his compass when he is making a turn at night or in a fog, and he often gets lost and all mixed up in his bearings when such a turn indicator is not before him, under these conditions. The white dial of the *turn indicator* is treated with a radio-active substance so that it glows in the night time.

AIRPLANES WITH PARACHUTES.

At least one airplane exhibited at the show was supplied with an independent parachute, which is said to work effectively and to take up but very little room. It can be readily put into action at any instant.

All in all, the airplane show appealed equally to everyone—men, women, and children. The great strides made in providing comfort in the planes, both large and small, proved a great drawing card. Some of the planes looked really more "comfy" than our finest automobiles, and give the effect when looking down into their passenger compartment, of the highest class railroad Pullman cars.

Electric lights were fitted in the same manner as those in Pullman car berths, and their glass bulls' eyes nestled in the leather upholstery of the ceiling, in some of the machines.

The handling of the machines has been greatly simplified so as to greatly resemble the driving of a modern motor car, and it was noticeable that the "joy-stick" has given way to foot control levers and steering wheels, the same as on automobiles.

The handling of a plane today, is far different from what it was a few years ago, and one can hop into the seat of one of these up-to-date aircraft—throw on the gas and the self-starter, and in half a minute be rolling over the ground at from 40 to 50 miles an hour, ready to glide up into the air.

A gigantic transcontinental aerial flier was exhibited by the Thomas-Morse concern, but the "grandaddy" of them all, was a whooping big plane which almost scared you to death to look at it—with its 105 feet of wing spread and its three 400-horsepower Liberty motors, which was exhibited by the L. W. F. Engineering Company.

(*Continued on page* 68)

Aladdin's Lamp

By CHARLES S. WOLFE

AN average chap, average if there ever was one, was Johnny Hartman. That old saw about the gods making mad those whom they are about to destroy is probably true. Usually they make very commonplace those whom they are about to exalt.

Hartman had been to college; but it had been a flying trip. In his capacity as driver of a wholesale drug house dray, he had once delivered a load of laboratory apparatus to the local "prep" school. His career as a student had stopt short in his freshman year at the high school, and it cannot be truthfully said that up until the day of his leave-taking had he given any promise of becoming good in any particular branch of study.

His very best work had been done in the creek, and this, unfortunately did not figure on his monthly report card, except indirectly under the head of "Days Absent." His parents, glancing over these report cards, had discovered startling discrepancies, or more correctly, perhaps, startling *regular* discrepancies, in the number of days per month that Johnny was supposed to have been at school and the number of days which the card showed he had actually been there.

At the impromptu court-martial presided over by his father that followed the arrival of a particularly bad report card, Johnny had been unable to present any evidence of a consequential nature in rebuttal. Sentence was duly past, and Johnny joined the ranks of the toiling millions. No great industrial upheaval followed the arrival of this recruit into labor's army. He did not set the world on fire. For that matter, he didn't even strike a tiny spark.

A semi-technical article in a Sunday Supplement started Johnny on his amazing career. Becoming, Heaven alone knows why, mildly interested in the matter set forth in the article, Johnny began verifying some of the statements made by the writer. Like the chap who read Webster's Unabridged from cover to cover, he found them correct. But in his experiments he had used a dry cell and a simple electromagnet. His interest piqued, he began to hunt down the "why" of that dry cell, and from that day on he became a confirmed dabbler.

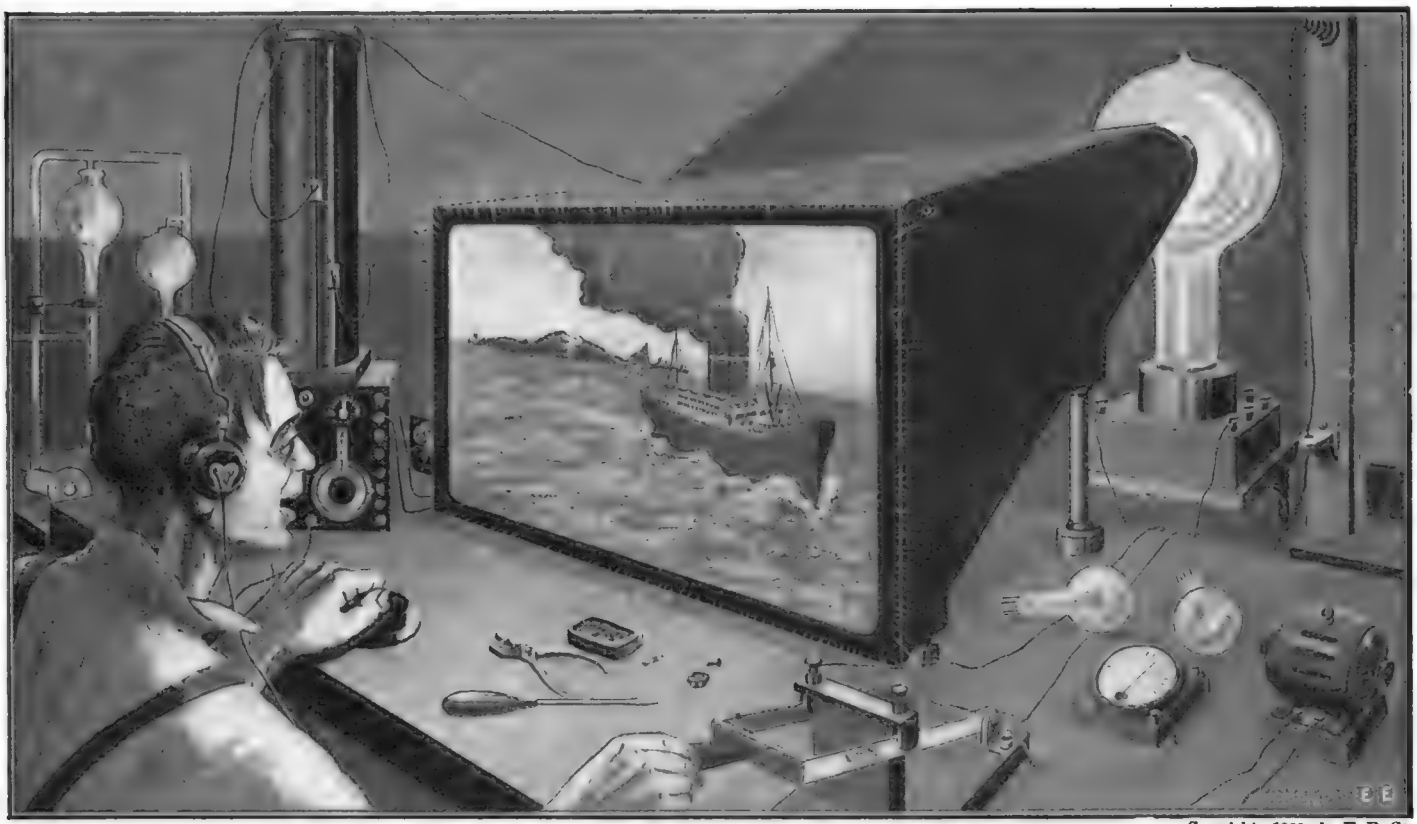
As the years went by they did to Johnny what they do to most of us. The average number of ups and downs; mostly downs. First his mother past into the Great Beyond, and by the time the poignant misery of this loss had become a dull ache, his father had also solved the Great Riddle. Johnny was now alone in the world.

Rooming house after rooming house followed, each move effected with more difficulty than the last because of the ever-accumulating bunch of junk that he was gathering together. As a compensation for his trouble along these lines, came his increasing knowledge of things electrical and mechanical, and he had long since wished his dray off on another unfortunate, having secured a fairly lucrative and admirably steady position with a firm of electrical contractors. Johnny will never know just how much he was valued by that firm. His knowledge of the things with which he worked extended beyond the practical into the theoretical, and as a consequence, he was unconsciously applying his superior knowledge to his daily installations. He was known to his employers as a man who met and mastered the emergencies of his business with unusual skill. And so he stood—all unknowing—at the age of twenty-eight on the brink of the Great Discovery, passing his days among motor installations and house-wiring parties and his nights in his little room and laboratory among Oudin and Tesla coils and high frequency phenomena.

On this particular evening, a goodly portion of an unfortunate steer safely tucked away in his stomach, he entered his laboratory for his customary night's recreation. Of late he had been dabbling in an aimless sort of fashion with vacuums. Meandering serenely thru many hours, he had succeeded in turning out electric incandescent lights that performed creditably, and had logically followed it up by duplicating the work of Fleming and De Forest. It requires only a brief paragraph to record these facts, but it had taken Johnny many an evening of hard and patient labor, accompanied by more failures than successes to reach that stage.

Working with hot glass is quite a trick, and when you have to dig out the processes for yourself it is terribly hard. From the

(*Continued on page 78*)



Copyright—1920—by E. P. Co.

". . . . A Queer Flickering Light Hovered Over the Whole Front of the Big Mysterious Box. . . . It Grew Brighter. . . . Vague, Shadowy Blotches Filled the Screen, Where That Weird Light Played. Hartman Was Tuning Frantically. . . . And Then, Suddenly, It Was There on the Screen—the Moving Picture!"

MARTIAN STUDENTS

FOR THOSE WHO READ THE ARTICLE, "HELLO MARS" IN THE APRIL NUMBER

GOUKA = CAT

The Dark Searchlight

By LEWIS YEAGER

The Accompanying Photos Show the Inventor of the "Dark Searchlight," as He Calls His Instrument, Experimenting with the Apparatus by Means of Which It Becomes Possible, He Claims, to Take Moving or Stationary Views in the Dark Without the Persons Photographed Knowing It.

The Two Top Photos Show the "Dark Searchlight" Camera and the Inventor With One of the Instruments, While the Two Lower Photos Show Mr. Yeager and the Powerful Light Used in Taking the Pictures, and at the Extreme Right an Experiment with the New Device.

JUST as wireless was designed to aid the human ear, the dark searchlight was evolved to make it possible for the human eye to see in the darkness without being seen. It is for the purpose of answering many questions asked me and for stimulating others to do research work in this line that I submit this non-technical description. The machine was suggested as a defensive weapon for this country during the war. This article will also allude to the use of the device as a police weapon and sporting apparatus. First, we will consider the needs of such an improvement, then we will consider descriptions of simple contrivances used in testing out the system.

The dark searchlight suggestion was made to the consulting board before the war ended in order to safeguard the Americans against the enemy contrivances. Having followed some of the foreign inventors in their systems of transmitting photographs by wire and in the process of photographing speech, I knew it was possible they had perfected the process without the knowledge of the Allies. The consulting board suggested that I send samples of the work after the device passed from one committee to another. This letter reached me shortly before the close of the war.

As the layman knows a searchlight cannot be used in war-time at night without giving away a position to the enemy. The ideal soldier would be one who had the power of night vision or could see in the darkness without being seen. As the schoolboy would term it, the soldier needs "cat's eyes."

THE DARK SEARCHLIGHT.

The dark searchlight is based on the principle that the photographic plate is quicker than the human eye in catching an impression. The ordinary section of moving picture film is made with successive exposures. The ordinary film is made at the rate of sixteen exposures per second. This does not mean that the sixteenth of a second is required for the exposure if we wish to split hairs on the point. It must be remembered that the film must be jerked in front of the lens barrel of the camera between the exposures.

With the dark searchlight we illuminate a spot and make the exposure so quickly it escapes the nerves of the eye, and the observer is able to use a searchlight without being seen.

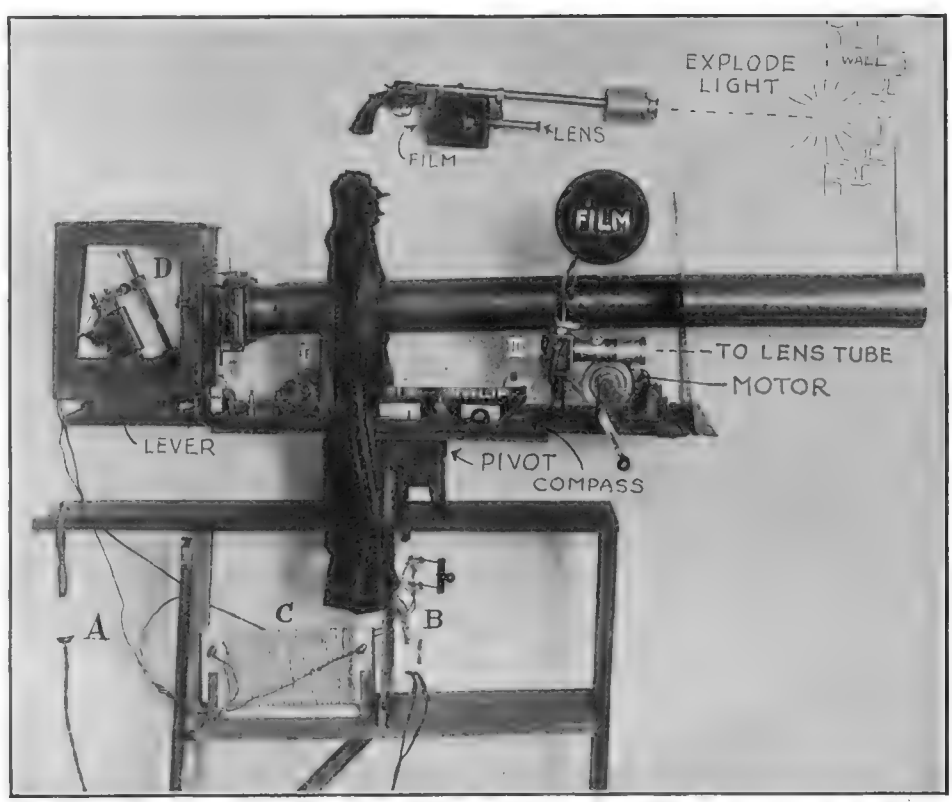
We must use an actinic light for the searchlight proper and a special sensitized plate for the observation fixation. After the plate or film is exposed it may be prepared as in ordinary photography. It will be understood by the layman that the idea is for the camera used in connection with the light of actinic value to catch an image in so brief a period the eye of the individual observer did not see the light beams.

We must not only have a light source, but must have it under control to the extent it may be projected upon a spot for the fraction of a second, while the telephoto lens is directed on the same spot. We must also have equipment or the camera proper for capturing the reflection the instant the light is uncovered.

THE SIMPLEST APPARATUS.

We will now take up the simplest apparatus which could be tested, then discuss more complicated plans:

The simplest form of apparatus which may be considered is shown in sketch (Fig. 1). This scheme provides a hand contrivance. A camera is used with a special flashlight torpedo and gives a range as far as the observer can throw the illuminating device. The camera, in the hands of the observer, with the shutter



The "Dark Searchlight Gun" Is Shown Above—It Projects or Fires a Magnesium or Other Cartridge While the Camera Takes the Picture. The Large Machine Shown Below Is the One On Which the Inventor Has Spent Most of His Time. The Principle of This Startling Invention Is to Project a Spot of Light From the Arc, of Such a Short Duration that the Eye Will Not Perceive It, Which, However, Will Enable the Person to be Photographed by the Extra Sensitive Film of the Camera.

open, is directed on a certain spot. The torpedo is thrown and explodes the percussion cap and ignites the actinic powder for the observation.

The second step in the evolution and a small machine which proved interesting and successful is illustrated in Fig. 2. This was a combined firearm provided with a silencer for the sound and a damp fabric to eliminate the flame from the weapon. The bullet included a spindle nose with a percussion cap at the tip and the spindle surrounded by the actinic powder. The camera attached was left open when the arm was discharged. As soon as the nose of the projectile struck a solid body, it exploded the magnesium charge. Of course this only hid the observer; the light at the point where the charge exploding giving away the fact an observation was being made. This machine has the advantage of great range with less weight than where electric light sources are used. The disadvantage of the machine is that it does not conceal the fact photos are being taken. The observer is in no danger, however, as the sound and light from the firearm is eliminated.

I am giving space to descriptions for the same reason that the instructor in radio tells his pupils how corks bob up and down when a stone is tost into the water. Much of the material in this article is for the purpose of instruction and to encourage the amateur.

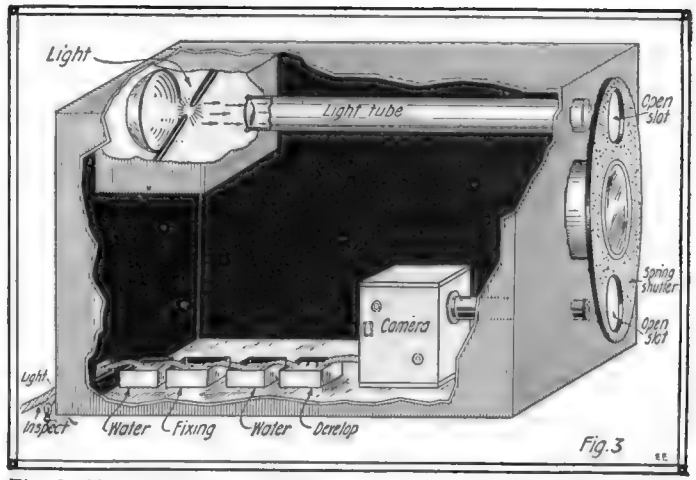
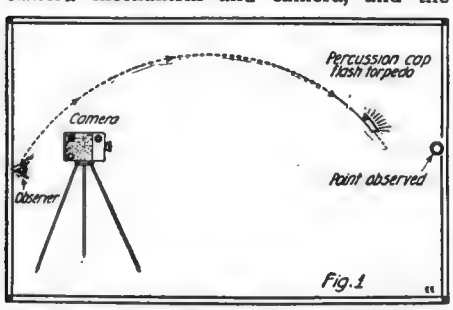


Fig. 3, Above, Shows a Simplified View of the "Dark Searchlight" Camera and Light Projector, Together With the Successive Developing, Washing and Fixing Solution Trays Thru Which the Film From the Camera Passes, So that the Photographic Images Are Very Quickly Available for Inspection.

GENERAL PLANS FOR THE MASTER MACHINE

The dark searchlight plans offered to the government in order to give the experts the idea consisted of:—The light source proper; the projecting lenses and tube to prevent fogging of film; the motor-driven camera mechanism and camera, and the



The Above View, Fig. 1, Shows How the Magnesium Cartridge or Other Form of Illuminant Operates in Conjunction With the Camera—the Observer and Position Where the Camera Is Located, or the Person Projecting the Flash Cartridge Being Unknown to the Victim.

developing and fixing bath. The apparatus mounts much on the order of a machine gun.

A number of materials may be used in obtaining a light source where the light will have actinic value. Magnesium wire, mercury and the ordinary electric arc are among the light sources rich in actinic qualities. Lenses must be used which will not kill this value.

Reflectors, projecting lenses and the like will not be discust here, as they are well known.

A good spring motor will drive the camera gears if it is desired to take a number of exposures. The gear must be such that only one picture is made with several seconds of time intervening. The film is fed from an upper reel to a lower toothed gear if the observation is made by an ordinary movie camera.

When the film is exposed it is fed into the bath for developing, then fixt, after which it may be inspected. The human eye, with the aid of the machine, has been able to make it possible to see in the darkness without being seen.

Methods of photographing a compass to give the exact direction in which the picture was taken and means for revolving the machine will not be described here.

I found it easy to synchronize the shutter of the light by using an electric circuit. The shutter of the camera closed a contact completing a circuit when the exposure was made. This energized a magnet at the searchlight and opened the shutter for an instant. (Two slots in a shutter.)

HOW THE DARK SEARCHLIGHT IS USED

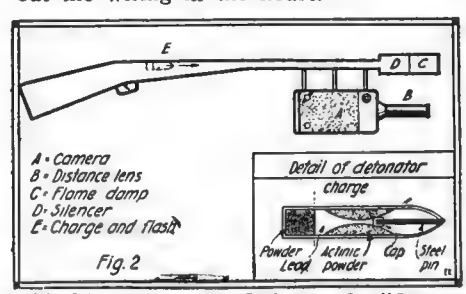
To take an observation the operator starts the motor after the machine is directed where a territory is to be scanned. The light is in operation but is concealed by the shutter. As the film shutter opens for the exposure, the shutter in front of the light source is tript and the light is released for the fraction of a second. A fraction of a second later the lens shutter opens the circuit and the searchlight shutter cuts off the light. The machine is directed onto another spot and the operation is repeated. The film is fed into the bath for developing and fixing.

OTHER USES

Other than military uses I will suggest some freak use or uses of value for the process. When the machine is adopted for commercial use, the hunter may count the ducks on the lake before the sun rises. He will photograph them without so much as the possibility of disturbing them while he arranges for a "pot" shot. Now for a use which I fear will shock some younger readers of the ELECTRICAL EXPERIMENTER. Like all inventions the dark searchlight will meet with opposition. I realize that park "cops" who meddle in the affairs of lovers and have the anti-spooning bug, may use it for unworthy purposes. For the sake of readers of this journal who may be the victims of the machine I will give them a secret process for detecting the light by machinery.

If the Germans had been using the dark searchlight, it would have been possible for the Allies to have detected it. Now, readers, get this big idea as it may save you being the victim of the anti-spooning "cop" who makes use of the dark searchlight! If you fear being watched, use a head set in circuit with a battery and suitable detector such as a selenium cell. The detector must be sensitive to light. Now just as soon as a man or lady "cop" begins to take snapshots, hang out the detector and be prepared to beat it with the girl. She will admit right there you are worthy of being taken into partnership and you may form a "close corporation" just as soon as you have escaped.

If you are building your own selenium cells or using mercury, be careful about breathing too much of the fumes, and if using the arc light use enough resistance wire to absorb the heat, as you may burn out the wiring in the house.



This Illustration, Fig. 2, Shows the "Camera Gun" Devised by Mr. Yeager, Also a Detail Sketch of the Special Flashlight Cartridge Projected by the Gun. The "Gun" Is Fitted With a Flame Damper and Noise Silencer, So That the Person or Persons Photographed Cannot See Nor Hear the Gun When It Is Fired.

Experimenting with the dark searchlight process will certainly make you a "master experimenter."

(Note: Due to patent reasons several fine points of the dark searchlight's mechanism are not disclosed.—EDITOR.)

German Papers To Depend On Radio

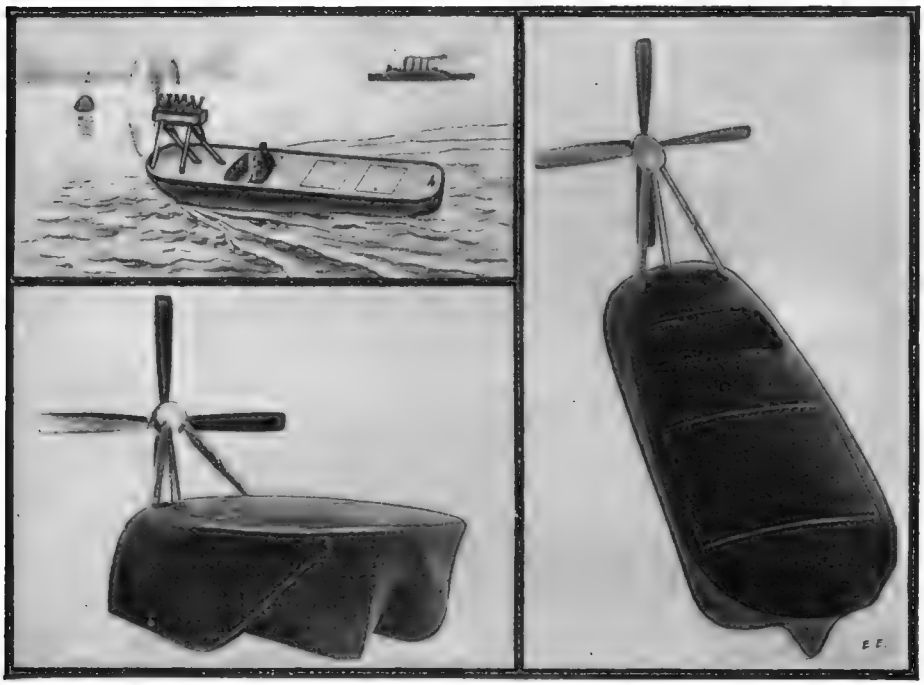
Wireless is to be widely extended in Germany, in especial for the press, if the plans of the ministry of posts and telegraphs mature. It is proposed to establish a collateral central in Berlin, and wireless plants in various wireless districts into which the empire will be apportioned. For this year the construction of 35 wireless stations and 50 receiving stations situated in important trade centers is planned.

Germany needs such an arrangement, for its telegraph service is severely criticized, and in addition to greatly increased prices, it is now necessary to telegraph the simplest, shortest message urgent—at three times the ordinary rate. The wireless will be expensive, but it will be worth it to the newspapers and business houses to be sure of speed.

The German papers that comment on the innovation are hopeful, but call attention to the unreliability of the wireless and raise the objection that anyone may pick up a message, so that a paper having an apparatus might easily steal the news of another paper.

This is partially controlled by the fact that the wireless for the present is subject to the Imperial Ministry of Posts and Telegraphs, and no one may have a wireless without official permission. A private plant that misuses its apparatus will be suspended immediately—if the owner is caught. The press message thefts could be prevented, it is suggested, by the proper publicity regarding the offender. Circular dispatches will be a feature of the plan, whereby the same bit of news can be sent to any number of stations at once.

100 M. P. H. Air-Propelled Boat



The Latest Thing in Speed-Boats! By Means of an Air-Propeller and a High-Powered Engine, Together with Quadruple Convex Bottom, the Inventor Has Successfully Tested a Model Which Seems to Point to a 100-Mile-per-Hour Speed of To-morrow.

The Loudy Hydroplane here illustrated is an aerial propelled, quadruple convex bottom, speed boat, capable of 90 miles per hour in a calm. It is powered with a 400 horsepower Liberty 12-cylinder airplane engine, located aft of the pilot, and driving an 8-foot four-bladed propeller thru a shaft, bevel gear transmission. When the motor turns at 1700 the propeller turns at 1000 revolutions per minute. The boat is 24 ft. (between perpendiculars). It weighs 2000 pounds fully loaded, in racing trim, including pilot and mechanic.

The model shown in the accompanying photographs is one-twelfth actual size. It was tested in the Naval Tank at the University of Michigan in order to determine its hydro-dynamic resistance. The aero-dynamic resistance was computed from reliable data and added to the hydro-dynamic resistance, from which the horse-power required was computed. The "horse-power required" curve intersected the "horsepower available" curve at 90 miles per hour.

Several trial runs were made in order to determine the trim. The pitching moments due to the position of the thrust and resistance necessitated placing the center of gravity well aft. When this was determined the boat did not nose up or under, but maintained an even keel at all speeds. The boat planed perfectly at 18 m.p.h., at which speed the bow wave disappeared. The wake was clean and low. There was absolutely no spray. In coming to a stop, the boat settled rapidly and pocketed the water at the bow, coming to rest in a very short distance.

Rudders are placed on either side of the step and work in conjunction. The boat turns readily due to the out-curving water-lines at the bow, banking into a turn instead of out of it, as most boats do. This boat is non-capsizable due to its shape.

With a 700 H.P. Fiat airplane motor, a boat of this same type would make 104 miles per hour.

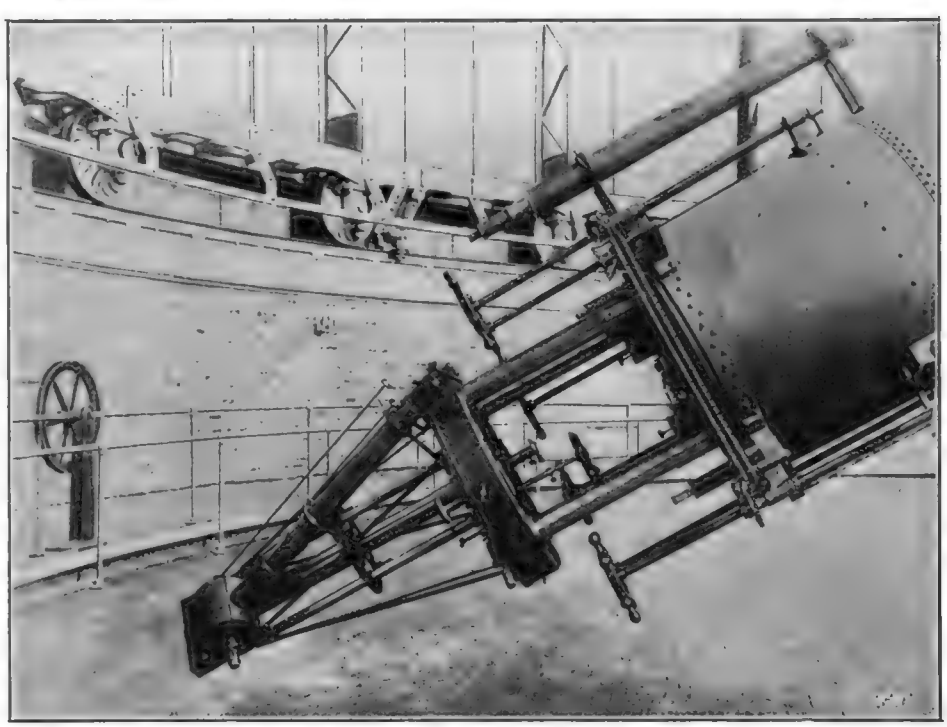
The Astronomical Spectrograph

By FLOYD L. DARROW

HERE we see the Bruce spectrograph attached to the eye-end of the 40-inch reflector at the *Yerkes Observatory*. The essential parts of a spectrograph are: (1) A very narrow slit thru which passes the beam of light, (2) a small telescope called a collimator, at the focus of which the slit is placed, (3) a prism to disperse the light into its component colors, and (4) an observation telescope to produce a magnified image of the spectrum. To be used as a spectrograph for photographing the spectrum, three prisms are usually employed, so as to obtain a greater degree of dispersion, and a plate holder is substituted for the eyepiece.

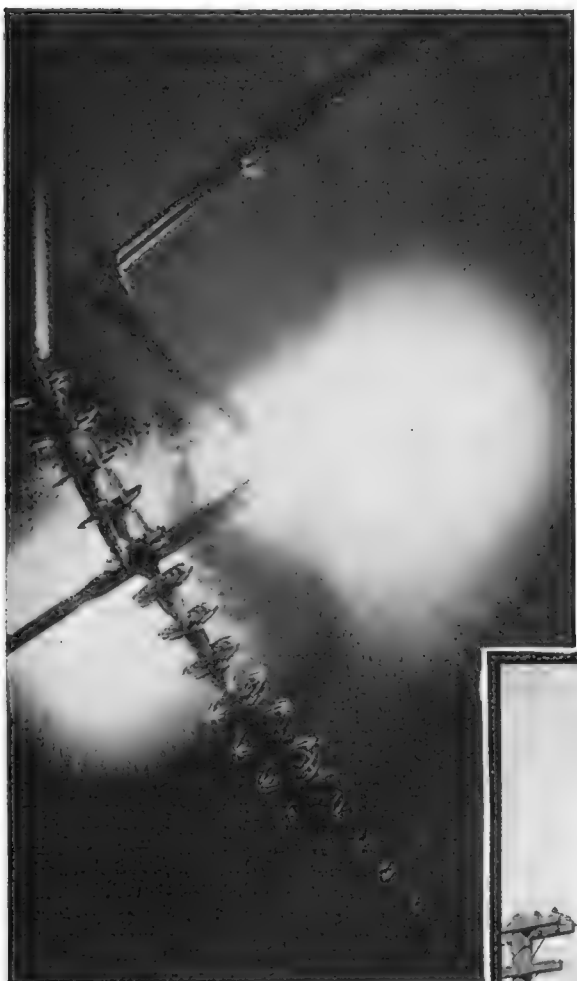
In the photograph we can see the collimator centrally placed, which receives the light gathered by the huge lens and transmits it to the three prisms contained in the circular case at the bottom. The light from the sun falling upon the first prism at the proper angle is dispersed into the colors of the rainbow and passing thru the other prisms undergoes further dispersion, emerging as a broad band of color, which is focust by the observation telescope upon the sensitive plate. In this photograph the eyepiece and not the plate holder appears.

Light is an electromagnetic wave motion in the ether of space, the waves differing from those that produce wireless and heating effects only in length. Wireless waves are very long and of low pitch; light waves are very short and of high pitch. Color itself is simply pitch (or frequency), the red waves being long and the violet waves short. Within certain narrow limits the human eye is sensitive to these waves. On one side of the spectrum, however, we have the invisible or infra-red and on the other the ultra-violet. Now it is due to this inequality in wave length that light undergoes dispersion. The shorter the wave length the more the velocity of light is retarded in passing into a dense medium like glass. Therefore the violet waves are retarded most and the red least. This results in the emergence of the light separated into its colors with red and violet at the ends and the other colors lying between. (*Continued on page* 111)



This Photo Gives an Excellent Idea of the "Solar Spectrograph" as Fitted to the Eye-End of the 40-Inch Telescope at the Yerkes Observatory. The Spectrograph Enables Us to Analyze the Structure of the Stars and Nebulae of the Heavens, for Every Incandescent Vapor Has Its Own Characteristic Spectrum Color.

Largest High Frequency Laboratory



Photograph at Left Shows a Test Being Made at High Voltage and High Frequency on a Chain of Suspension Insulators of a well known type. The voltage on this test was 150,000,—the Corona Having Been Started by a Potential of 207,000 Volts, the Corona Always Being Maintained by a Lower Voltage Than the Initial Potential Required to Start It,—While the Frequency Was 48,000 cycles Per Second.

THE insulating of apparatus for voltages of from 100,000 to 150,000 at sustained frequencies varying from 15,000 to 500,000 cycles per second, such as used in radio telegraphy, is a far more difficult problem than that of insulating for the same voltages at "commercial" frequencies, such as 60 cycles per second.

To study this problem, the Federal Tele-

Photograph at Right Shows Large Building Containing High Frequency Apparatus, Erected and Used for Testing Purposes by the Federal Telegraph Co., at Palo Alto, Cal. The Exciting Current for the High Frequency Apparatus Is Supplied to the Air Condenser from a Poulsen Arc, of the Type Used in Long Distance Radio-Telegraphy. This Laboratory Is Unique, and So Far as Known, Is the Largest of Its Kind in the World. It has Sufficient Power to generate a Potential to Earth, of Half a Million Volts, at a Frequency of 50,000 to 100,000 Cycles Per Second.

graph Company built at its plant at Palo Alto, California, a great high voltage laboratory, in which it is possible to duplicate the high voltage and high frequency phenomena which have to be met with in operating a high power radio station.

The building which constitutes the high-voltage laboratory is shown in the large photograph herewith. This building consists of a wooden framework lined with corrugated iron. It not only acts as the shelter for the apparatus but forms the grounded plate of the air condenser. The high potential plate of the condenser, which has somewhat the appearance of a life raft, is mounted on top of the porcelain supports. This plate corresponds to the antenna of a radio station. Beneath the high voltage plate is the loading inductor (not shown in the picture) sometimes known in radio stations as the "loading coil." Current is supplied to the air condenser from a Poulsen arc, such as is used in the arc radio transmitters manufactured by the Federal Telegraph Company.

The laboratory is unique in that it is capable of generating a potential *to earth* of half a million volts, which is about as high as is obtainable in any of the 60-cycle, high-voltage laboratories of the country, and at the same time this voltage is generated at a sustained frequency of 50,000 to 100,000 cycles per second. Thus this laboratory is the largest of its kind in the United States, and, as far as is known, the largest in the world.

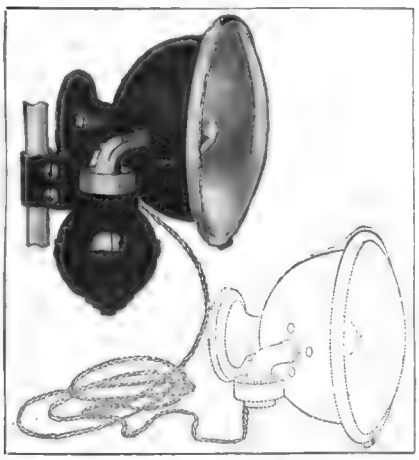
The smaller photograph shows a test being made on a string of suspension units, such as used on high-voltage transmission lines, which are, in this case, equipt with a corona shield. The photograph shows corona plumes two to three feet long maintained by a potential of 150,000 volts at a frequency of 48,000 cycles per second. Corona first appeared at 207,000 volts.

(*Continued on page* 114)

...Automobile News...

AUTO REEL LIGHT.

The Autoreelite is a combination of three lamps in one—Spot Light, Trouble Light and Portable Light. Inside of the ball casing is a reel containing 12 feet of elec-



This Auto Light is Something Quite New and Should Meet with Great Favor Among Motorists Everywhere. It Combines a Spotlight, Trouble Light, and Portable Light with Twelve Feet of Flexible Cord.

tric cord which permits the light to be carried anywhere within 12 feet of the windshield.

When you wish to inspect any portion of your car at night, simply remove the lamp from its support and the 12 feet of cord permits you to carry the light anywhere round the car. The cord reel winds and unwinds like a curtain roller.

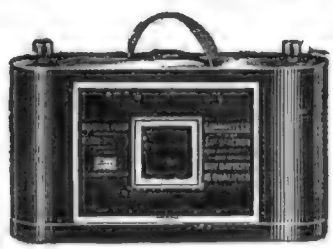
This lamp is the only one manufactured, it is claimed, that combines a windshield spot light, a trouble light and a portable light, and the cost of the Autoreelite is no more than that of an ordinary high-grade windshield spot light.

The 12-foot extension cord and reel are contained in the small, neat ball casing attached to the bracket.

DRY CELL IGNITER BATTERY.

The dry cell igniter battery illustrated is simple in construction, strong and durable. A specified number of dry cells, properly and permanently connected together are put into a moisture proof container. The cells are perfectly insulated from one another and hermetically sealed in the container, so that only the two terminal binding posts and the carrying strip protrude thru the sealing compound.

The terminal nuts on the binding posts are embedded in a square shaped knob of insulating material so that a wrench or



A New Compact Form of Dry Cell Ignition Battery for Auto Requirements.

strip of metal accidentally in contact with both binding posts will not cause a short circuit. The size and shape of the insulated terminal nut permits sufficient pressure to be exerted to insure a perfect and permanent contact without using pliers. The carrying handle is of strong webbing, having the ends securely anchored in the interior of the battery. The positive and negative posts are indicated by the proper symbol stamped on the sealing compound alongside the binding posts.

The method of construction, necessarily eliminates all trouble from moisture, loose terminals, broken or improper connections and is a time saver to the user. The space occupied is no more than that which would be taken up by an equal number of standard dry cells, so that these batteries will fit standard size battery boxes in any case.

The carrying handle is a convenience that will be appreciated by everyone who wants to use the battery for different purposes: for example—a farmer could use it on his tractor, his automobile, his pumping engine, as circumstances require, by simply disconnecting it from one and connecting it to the other. This general utility feature of the sparker unit should appeal to every user because of the saving in time, as well as for its convenience and economy.

$50.00 In Prizes

Beginning with our July issue, we shall print on this page a new automobile department entitled "Automobile Stunts", and we will pay $50.00 in prizes for the three best articles received each month.

A great many of our readers have a car of their own, and any number of them have made certain improvements on that car. We want to know about these improvements. Almost every other automobilist some time or other invents a little device or does something to his car to make it better than it was before. "Experimenter" readers want to duplicate these stunts, and that is just what this new department will be for. In other words an exchange of ideas. Note that the idea does not necessarily have to be electrical in any way. You may have a new stunt or trick how to patch a blown tire that was not described before. You may have a new idea how to prevent your spark plugs from carbonizing, and thus short circuiting. You may know of a new stunt how to refill or charge a storage battery. If you have a town car, you may have thought of some simple trick how to signal to your chauffeur, so he will know where you will want to go.

There are hundreds of such ideas, and we will pay $50.00 a month to get them. Of course, we would like to have a photograph of the stunt showing that it was actually tried, but this is not absolutely necessary to win a prize. If no photograph can be furnished—altho we would like to have it—a simple sketch will do showing the essential parts, etc.

We will pay the following prizes:

FIRST PRIZE	**$25.00**
SECOND PRIZE	**15.00**
THIRD PRIZE	**10.00**

All other accepted articles, which win no prizes will be paid for at the rate of $2.00. Articles submitted should not be long ones. About the size of the ones shown on this page will do. Address all manuscripts to "Editor, Automobile Stunts," care of this publication.

MAGNETO DEFECTOMETER.

For use by electrical repair men in locating magneto troubles, the outfit shown in the accompanying illustration is now being made by a Chicago concern. By means of this outfit, it is said that it is possible to determine whether a condenser is out of condition, whether a collector is defective or whether an armature is dead. The arrangement of the outfit is such that the condition of the armature can be determined by the action of a vibrating spring. Directions accompany the instrument outlining the indications for a perfect armature and also indicating how faults on damaged armatures show up.

This Instrument Quickly Locates Defects Or Trouble in the Various Parts of Automobile Magnetos. By Means of This Instrument, You Can Quickly and Accurately Locate Trouble in the Condenser, Collector, or Armature.

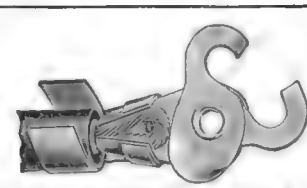
AUTO JOTTINGS.

As a matter of fact, it is only in certain parts of the country that we see many electrics running about, but among certain people there has always been and is now a profound respect for the clean and noiseless electric auto. The field of electrically driven cars has recently become enlivened to a greater extent than ever before by the advent of a number of new features and developments. Principal among these, we find the new light weight and rigidly built storage batteries and first and foremost in recent inventions,—the new Steinmetz automobile. In the Steinmetz machine, twice the horsepower is developed with the same motor and battery weight, by causing both the field and the armature to rotate, in opposite directions. The armature drives one wheel and the field the other, thus acting as its own differential.

CLEVER BATTERY TERMINAL.

These terminals are suitable for both primary and secondary winding and are claimed to insure perfect connection at all times, and in view of the fact that the contact blades or jaws of the terminals are of spring brass, bent in opposite directions, they prevent the possibility of being jarred loose by vibration.

It is not necessary to remove the thumb nut on spark plug or battery terminal in order to place these connectors into or out of service; all you have to do is simply to loosen the binding nut, open the jaws of the terminal clip, close them around the screw of the terminal base, and tighten up the nut.

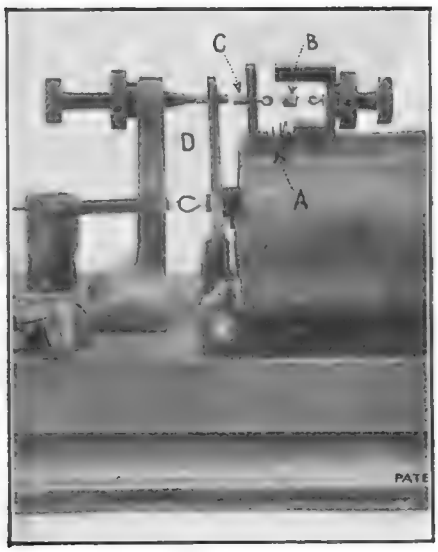


Detachable Spark Plug and Battery Terminal Combining Excellent Electric and Mechanical Principles. All You Have to Do Is to Simply Loosen the Nut and Insert or Remove This Hinged Lug In a Jiffy.

110-Volt D. C. or A. C. Telegraph Relay

By Donald McNicol

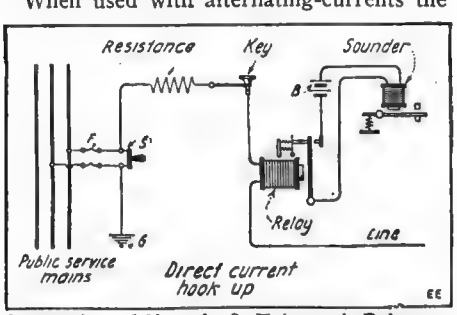
This new universal relay for single line Morse telegraph or other signal circuits operates on 110-volt alternating or direct current. The relay is in appearance the



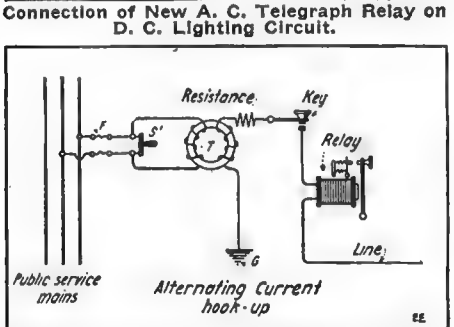
The Alternating Current Telegraph Relay —the Problem of Problems, Solved at Last by the Use of a "Floating Contact" Which Follows the Vibrations of the Armature.

same as an ordinary main line 150-ohm. telegraph relay. The adjustments are the same as with ordinary relays; that is, by movement of the electro-magnets relatively to the armature, and by means of a retractile spring attached to the armature. The relay will operate satisfactorily on any current strength from 10 to 200 milliamperes, and the current may be from a direct-current source or from an *alternating-current* source, of *any commercial frequency and voltage.* The view of the construction of the relay herewith shows a spring cushion contact in place of the solid contact heretofore used in signal relays. This cushion contact *C* is so designed that it is substantial and introduces no trouble-making complications. It involves a properly balanced floating contact supported by retractile and expansive springs, *A* and *B*.

When used with alternating-currents the



Connection of New A. C. Telegraph Relay on D. C. Lighting Circuit.



How the A. C.-D. C. Universal Relay Is Connected up to Alternating Current Lighting Circuit.

relay armature remains in *floating contact* with the relay front-stop as long as the relay circuit is closed. A sounder operated by the relay is actuated faithfully and exactly the same as with direct current.

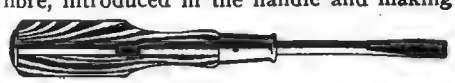
The main advantage in using this relay is that to operate telegraph lines there is no necessity for the setting-up of motor-generators, primary batteries, or storage batteries; a lamp-socket connection to the public service 110-volt, 60-cycle mains is all that is required. In case the public service system is an ungrounded one an inexpensive transformer may be used and one terminal of the secondary grounded as shown in the A. C. hook-up.

The relay is now in use as a district-service relay in New York City and has been tested on lines 200 miles long operated by a Vibroplex transmitter, the received signals being exactly as clear as if direct-current had been used.

Alternating-current sounders are now on the market and may be used in connection with this relay. In case a. c. sounders are not desired an ordinary d. c. sounder may be used, or a dry-cell sounder of a type which uses current only when the relay is open. See D. C. diagram. Ordinarily a telegraph circuit is closed at least two-thirds of the time; if, therefore, current is used to withdraw the sounder armature, and a spring used to close the sounder armature, it is clear that the life of the dry cell local battery will be proportionately prolonged.

AN INSULATED SCREW-DRIVER THAT PREVENTS SHOCKS.

A distinguishing feature of the new insulated screwdriver is the insulation of hard fibre, introduced in the handle and making



An Essential Tool for All Electrical Workers —an Insulated Screw-driver.

it shock-proof under all conditions (rupture point 10,000 volts) and serving as part of, what is in effect, a continuous shaft, with a heavy rivet head. This makes it especially useful in work on automobiles and all electrical installations.

The form of the handle has been carefully planned to combine grace of design with these practical advantages.

NEW VITREOUS ENAMEL RESISTANCE UNITS.

A new departure in enamel resistance units is incorporated in the type here shown. It is built on a porcelain tube, giving perfect insulation. Grounding is impossible. No iron core with attendant self-induction is used, also no mica or asbestos. The wire used has practically zero temperature. The wire will not change its molecular construction thru service at rated temperature, and will not age and offer a different resistance in ohms. Joints between fine wire resistance and heavy terminal leads are made while parts are clean and bright under high pressure—then sealed in enamel at high temperature. There are no soldered joints that are uncertain and hazardous, and that cause disintegration of resistance wire during the process of soldering.

The insulation is vitreous enamel, one of the best insulators known. The entire unit is "sealed" in enamel, insuring against electrical, mechanical and chemical depreciation. No cement, japan or black paint, nor mixture of cement, sand, asbestos chips and powders—no porous insulation, either with or without a spotted skin effect are used, the makers claim. Flexible terminal leads of copper braid of any length desired are furnished. No limit as to location or length of leads. No moisture can reach the resistance wire. The units are rugged, permanent, compact and practically non-in-

New Vitreous Enamel Resistance Units — the Wire Is Wound on a Non-Inductive Porcelain Core. No Soldered Joints are Used. Coil Sealed in Enamel.

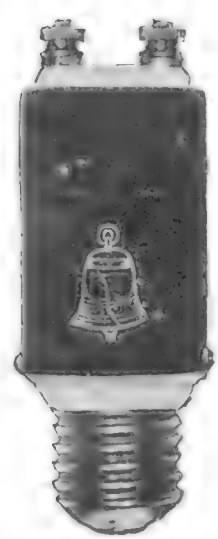
ductive. Any resistance or capacity desired is available.

(So enthusiastic are the makers that they will send a sample free of charge to all interested parties. A self-enclosed envelope to our "Technical Information Bureau" is all that is required.—EDITOR.)

THIS STEP-DOWN BELL TRANSFORMER SCREWS IN SOCKET.

The step-down A. C. bell transformer here shown strikes a new note in the construction of bell transformers, in that it is of the socket type, and may be connected to the line by simply screwing into any Edison base socket or receptacle. This permits even the inexperienced to connect it. Also the method of connection permits the easy removal from one house to another, should the family move. All bothersome soldering is done away with in the installing of this transformer. The complete weight is only one-half pound, and the 10-volt type will ring four 2½-inch bells, while the 16-volt type will ring seven 2½-inch bells.

The transformer is enclosed in a neat black enameled shell, with the secondary terminals brought thru a porcelain block, conveniently placed. The transformer is well made, and impregnated, and does not depend on any filling compound to exclude moisture. The device will not burn out on short-circuit of the secondary terminals, and has an input of only 10 watts on short-circuit. This form of transformer is being more widely adopted every day to serve instead of batteries for ringing bells and operating annunciator systems.



Attachment Plug and Transformer Combined.

New Electrical Utilities

NEW 10,000 REVOLUTION ELECTRIC DRILL.

A new electric motor driven drilling tool is being put on the market by a western concern. The machine is adapted for use by manufacturers and jewelers for light,

Electric Motor Drill Which Is Capable of Drilling at Speeds of from 500 to 10,000 Revolutions Per Minute.

sensitive work. The illustration shows the machine equipt with a direct-connected, variable speed type of motor, together with a spring chuck and a six-speed controlling unit, affording speeds varying from 500 to 10,000 revolutions per minute. The controller is mounted on the floor and is regulated by a foot pedal.

A wide range of operations may be very conveniently handled with this drill as it may be used with entire satisfaction on steel, cast iron, brass, aluminum, fiber, hard rubber, etc. The table is adjustable and gives the drill a stroke of ½". The capacity of the machine is for drilling holes up to 1/16" in diameter in steel and ⅛" in diameter in soft alloys. Holes can be drilled to the center of a 5" circle. The motor and chuck are in perfect dynamic or running balance, thus assuring smoothness of operation and accurate results.

MOTOR-DRIVEN GUM LABELER PRINTS SEVEN SIZES OF LABELS.

Designs of motor-operated labeling machines, such as shown in the accompanying illustration, have recently been developed by a Dayton, Ohio, concern, for a variety of purposes.

Motor Operated Machine that Will Make and Print Seven Different Sizes of Gummed Labels.

This machine will make and print seven different sizes of labels without change in adjustment. It is only necessary to change the roll of paper in order to secure the size of label desired. From 14 to 40 characters can be printed on tags, the number varying with the size. It should find a wide field of application in stores of all kinds, especially where the hand-written tag or label is rapidly being obliterated.

SOMETHING NEW IN ELECTRIC SOLDERING IRONS.

A new and highly unique, as well as efficient electric soldering iron has recently been perfected.

It differs from others, in that the current does not flow until the twin terminal touches the work to be heated. The terminals are of carbon, which almost immediately develops a very high temperature—up to 3,300 degrees C. As soon as the operation is completed and the tool taken from the work the current, of course, ceases to flow, as the circuit is open. The same company manufactures a copper-pointed iron which is heated on the same principle—that is the circuit is closed by allowing the iron, operated by a spring, to come in contact with the two carbon points. When this contact has been made it is said to take less than a minute to heat the copper ready for work. This iron can also be used as two-prong soldering tool by simply removing the tip. These tools are practically fool-proof, in that there is nothing

A Carbon Electrode Soldering Iron that Develops a Heat of 3,300 Degrees Centigrade.

to burn out and that the only parts requiring to be renewed are the carbon contacts.

ELECTRICAL RECORDER AND ALARM FOR BOILER WATER-LEVEL.

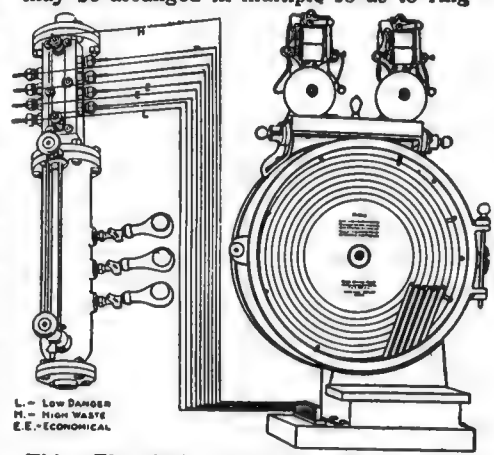
How often do unreasonable disputes arise between the chief engineer and the firemen as to the water level in boilers? A new clock driven water level recorder and alarm has been perfected to facilitate the maintenance of boiler room routine. This instrument *records* the level of your boiler water at all times. It shows where it is and has been, and the exact time it was at that level.

By its use the engineer and fireman can, if he will, guard against danger and loss from the extreme of too little water. He can learn to prevent all the losses and inefficiency arising out of a condition of too much water.

Moreover, surplus water in a boiler over the economical level destroys the proportions of its design and reduces the ability of the grate area to evaporate as fast or to as high a pressure. It also reduces the steam storage space provided besides calling for a given heating surface to handle more water than possible. The product is wet steam or foam, and the result is loss.

The makers of the new electrical water-level recorder seek to correct all this by helping to carry the level always at the economical line.

The instrument shows the level on a recording dial every moment, and when high or low is reached, alarms ring and signal lights flash. When on the economical line there is a white light constantly burning. It might be thought that the apparatus is quite a refinement for the boiler room, but such is not the case, as practise has demonstrated. The recorder itself is usually placed in the engine room. The alarm bells and lights are placed in the boiler room so that the boiler attendants can watch the boiler properly. The signals may be arranged in multiple so as to ring



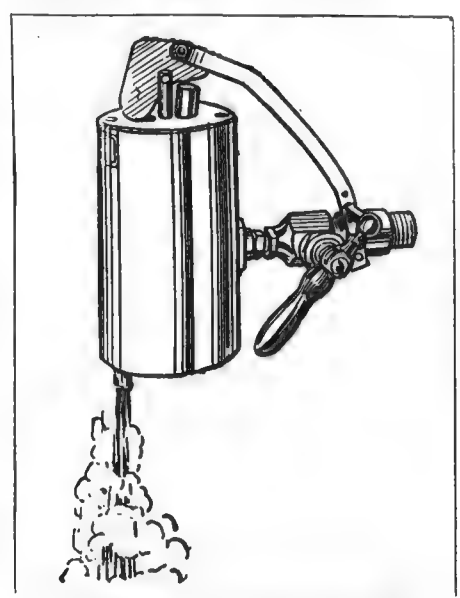
This Electrical Instrument Records the Water Level in a Steam Boiler at All Times, and Gives a Low-water Alarm. It Prevents Disputes in Boiler-room Operation.

or light up in two or more locations. Also the water gauge attachment and the recorder can be separated any distance desired.

ELECTRIC HEATER FOR RUNNING WATER.

The interior of this electric water heater consists of two compartments, the upper one of which holds the electric switch, and the lower one contains the heating element, consisting of a highly resistant metal alloy. The water passes thru this lower compartment, and as it is submerged it cannot be subjected to a heat temperature sufficient to injure it.

The heater may be attached to any ordinary water supply, and hot and cold water may be drawn from the same spigot as desired, the hot water being furnished only by the throwing on of the electric current, which is done automatically. The water being heated as wanted, there is no waste of electricity and 1¼ gallons a minute may be brought to a temperature of 115 degrees. Sufficient water for a bath may be heated in from 10 to 20 minutes.



This Electric Spigot Heats Cold Running Water at the Rate of 1¼ Gallons a Minute.

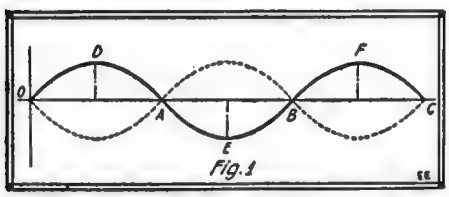
Experiments in Physics

By JOHN J. FURIA, A. M.

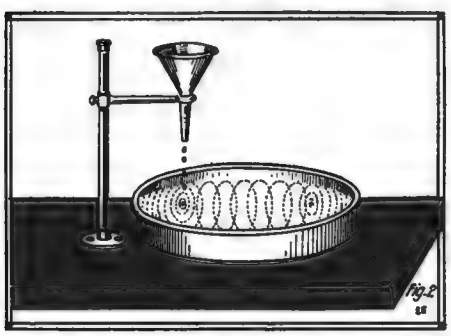
Department of Physics, N. Y. University

LESSON VI—INTERFERENCE

THE phenomenon of *interference* is a very important one in Physics and is usually misunderstood or not well understood at all by the elementary student. The reader should bear in mind that interference does not have the meaning of prevention which it commonly has. It means the combination of two



If a Rope About 20 Feet Long Is Attached to a Rigid Support, and Then the Free End Is Caused to Move Up and Down in Rapid Succession, Stationary Waves Are Set Up in the Manner Shown.



By Placing a Layer of Mercury in an Oval Dish, as Shown, and Pouring Some Mercury Into a Funnel, the Latter Dropping Into the Dish, Sets Up Waves in the Liquid Which Expand at the First or Originating Focus—and Converge at the Second Focus. The Second Focus in Turn Acts as the Origin of Waves and This Interferes With the Set of Waves From the First Focus, Producing Bands of "Interference."

waves which reinforce and neutralize each other alternately at regular intervals. A train of waves may be reflected so that the original train of waves and its reflected train may interfere or two trains of waves from different sources may meet and interfere.

PRODUCING STATIONARY WAVES.

If a rope about twenty feet long is attached to a rigid support and then the unattached end caused to move up and down in rapid succession *stationary waves* are set up (see Fig. 1). The rope is attached at

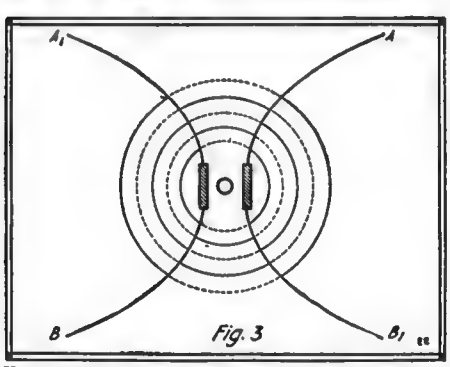


Fig. 3 Shows the Top View of the Ends of a Vibrating Tuning Fork. Each Prong Sets Up Waves of the Same Pitch and Points of Silence Will Be Found Along the Line AOB1 and A1OB, as a Test With a Second Tuning Fork Will Demonstrate.

O; the heavy line represents the original wave, and the dotted line the *reflected wave*. Each particle in the advancing wave is met by the returning wave tending to cause it to move in the opposite direction. For an advancing particle moving upward, the reflected particle moves downward and vice versa, leaving the particle undisturbed as at A, B and C. At D, E, and F, however, the particle of the original and reflected waves would both be in their lowest or highest positions and would double the effect of each wave, giving a displacement from the axis twice that of either wave. Because of the state of rest of each individual particle the combination is known as *stationary waves*. The incoming and reflected waves alternately reinforce and neutralize each other. This is an example of *interference* from a wave and its reflected wave.

Another excellent example of interference by reflection can be obtained by a liquid in a shallow dish. Construct a shallow dish elliptical in shape. Cover the dish with a thin layer of some heavy liquid, preferably mercury. Place a funnel with a fine opening over one focus of the ellipse and pour mercury into the funnel. The striking of the drops upon the liquid surface sets up waves in the liquid in the form of circles, expanding at the focus where the drops fall, and converging at the other focus. The second focus in turn acts as the origin of waves, and these interfere with the set of waves from the first focus, producing bands of interference (see Fig. 2).

SOUND IS A WAVE MOTION.

By *interference* waves can reinforce and neutralize each other. It follows then that two sounds can combine to reinforce each other and also produce *silence*. The pro-

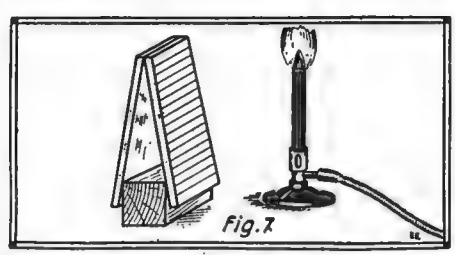


Figure Seven. In This Experiment Two Pieces of Plate Glass Are Separated at One End So as to Form a Wedge. With a Bunsen Burner Having a Little Sodium in Its Flame, a Series of Black and Yellow Lines Will Be Seen Across the Plates. This Experiment Must Be Performed in a Fairly Dark Room.

duction of silence by two sounds can be shown in many ways, the simplest being by the use of a tuning fork. So far we have considered only waves coming from one source. As stated before we can produce *interference* by waves from different sources. If a wave from one source arrives at a certain point in a phase of condensation and another from another source arrives at a phase of rarefaction, the effect of the two will be to produce no disturbance at all. If the waves in question are sound waves of the same pitch (frequency) this point will be one of continuous silence.

Fig. 3 shows an end view of a vibrating tuning fork. Each prong sets up a train of waves of the same pitch, causing the air between the prongs to alternately condense and rarefy while behind the prongs the air is alternately rarefied and condensed. The series of waves proceeding forward is represented in the figure by heavy lines (condensations) and the dotted lines (rarefactions). At all points along the lines AOB′ and A′OB rarefactions and condensations come together at the same instant (four points for each circle). Therefore at these points there will be *silence*. If a vibrating tuning fork is held near the ear and slowly rotated, it will be found that four distinct positions will give silence, all others sound.

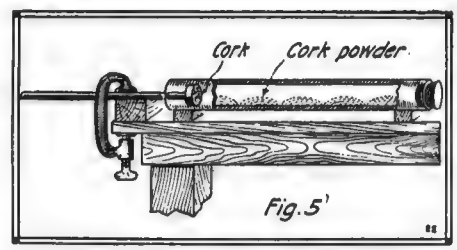


Figure Five. A Simple Experiment With a Glass Tube and Some Cork Powder. The Formation of Little Heaps of Cork Powder, When the Rod at the Left Is Rubbed and Vibrated, Demonstrates the Production of "Interference by Reflection."

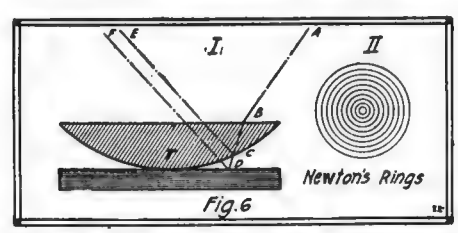


Figure Six. Showing How Interference Rings Are Produced in Light or Optics When the Eye at EF Receives Two Different Images From an Impinging Light Beam AB, Falling on a Lens T. In This Case, the Eye Will See Alternate Bands of Brightness and Darkness in Monochromatic Light—or Alternate Bands of Colored Light in White Light.

A piece of glass tubing is bent into the shape shown in Fig. 4 and two funnels are attached by means of rubber tubing at C and D. At A and B another piece of glass tubing is attached of diameter large enough to permit it to slide back and forth freely. When the tube ABF is adjusted so as to make the right and left sides of the apparatus equal in length, the ear placed at D will distinctly hear the sound of the tuning fork vibrating at C. As the tube AFB is

(*Continued on page* 85)

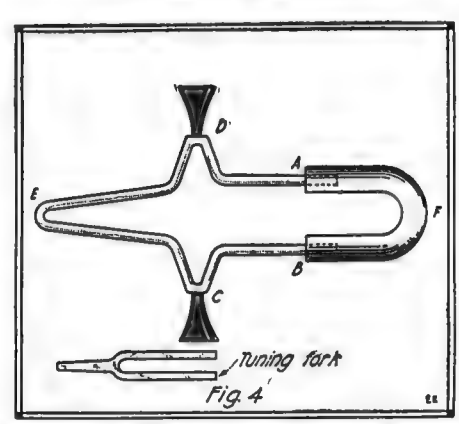


Figure Four. A Tubular Acoustic Device for Demonstrating the Effect of Interference of Sound Waves. The Ear Placed at D Will Hear Nothing When the Adjustable Tube F Is Moved to the Point Where the Waves Coming In From Each Side of the Tube Are Opposite in Phase and Neutralize Each Other.

Popular Astronomy

By ISABEL M. LEWIS, M. A.

of U. S. Naval Observatory

The Earth's Interior

UP to comparatively recent times the opinion was universally held that matter within the earth's interior existed in a *fluid state* at a tremendously high temperature. The flow of molten lava from volcanoes and the occurrence of hot springs and geysers testify to the fact that intense heat prevails beneath the surface crust of the earth as also the well-known fact that there is, on the average, an increase of 1° F. for every sixty feet of descent in mine shafts. If this law of increase held from surface to center the temperature would be sufficient to melt and volatilize all known substances at a depth of only sixty miles, while at the center of the earth a temperature of 350,000° Fahrenheit would prevail.

Now modern investigations of the temperature of the sun and the stars have made us more conservative in our estimates of the temperature of the earth's interior. It has been found that the temperature of the radiating layers of the sun are to be placed at only about 12,000° F. It is extremely improbable that any such temperatures would exist generally thruout the earth.

A most important factor affecting the condition of the earth's interior substance, is the pressure due to gravity of the earth material upon underlying strata.

Atmospheric pressure at sea level is fifteen pounds per square inch. A cylinder one sq. inch in cross-section and one hundred and forty-four feet in height contains one cubic foot and if filled with water would weigh 62.5 pounds and therefore exert a pressure of 62.5 pounds on the base of the cylinder. If filled with surface rock instead of water the pressure on the base of the cylinder would be about 165.5 pounds, the average density of surface rock being about 2.65 times the density of water. At a depth of one mile, therefore, the pressure exerted by the surface crust of the earth is about six thousand pounds or *three tons per square inch!* At a depth of one hundred miles the pressure per square inch would reach the tremendous value of three hundred tons per square inch, assuming that the density of the rock remains the same as at the surface and the force of gravity the same as at the surface. As a matter of fact both have changed slightly for a point one hundred miles below the surface but the effect is to increase the pressure rather than to diminish it.

The pressure increases in direct proportion to the depth only for a few miles beneath the surface. The *rate* of increase of both the pressure and the density falls off rapidly for great depths. Yet it has been estimated (by Legendre's Law), that the pressure near the center of the earth is approximately *three million times the pressure of the air at sea level* and the density of the material at the earth's center is about eleven times the density of water.

Now it is well known that pressure raises the boiling point of liquids and the melting point of solids and, therefore, the effect of pressure within the earth is to keep matter in the solid state. It is manifestly impossible to produce experimentally the conditions of pressure prevailing even at moderate depths beneath the earth's surface. Yet it is possible to get indirectly at the condition of matter in the interior of the earth from a knowledge of its surface density and of its mean density, which is found from its known mass and volume.

Direct analysis of surface rocks has establisht the fact that the average density of the earth's surface crust is 2.65 times the density of water. The mean value of the earth's density as a whole is 5.53 times the density of water. Somewhere within the earth's interior, then, its density must exceed this mean value.

Just how the density of the earth material is distributed from surface to center is the question.

According to Legendre's Law, mentioned above, the compression of matter due to the pressure of layers above is computed as for a fluid. This distributes the density so that the earth material has about eleven times the density of water within five hundred miles of the center of the earth, is about as heavy as steel, or eight times as dense as water half way down, and from 2.6 to five times as dense as water within five hundred miles of the surface.

According to another law known as the Roche-Wiechert Law it is assumed that the earth consists of a central nucleus or core composed chiefly of iron, density 8.2, surrounded by a stony shell of less density. The core has a radius that is approximately eight-tenths of the earth's radius. (See Illustration.)

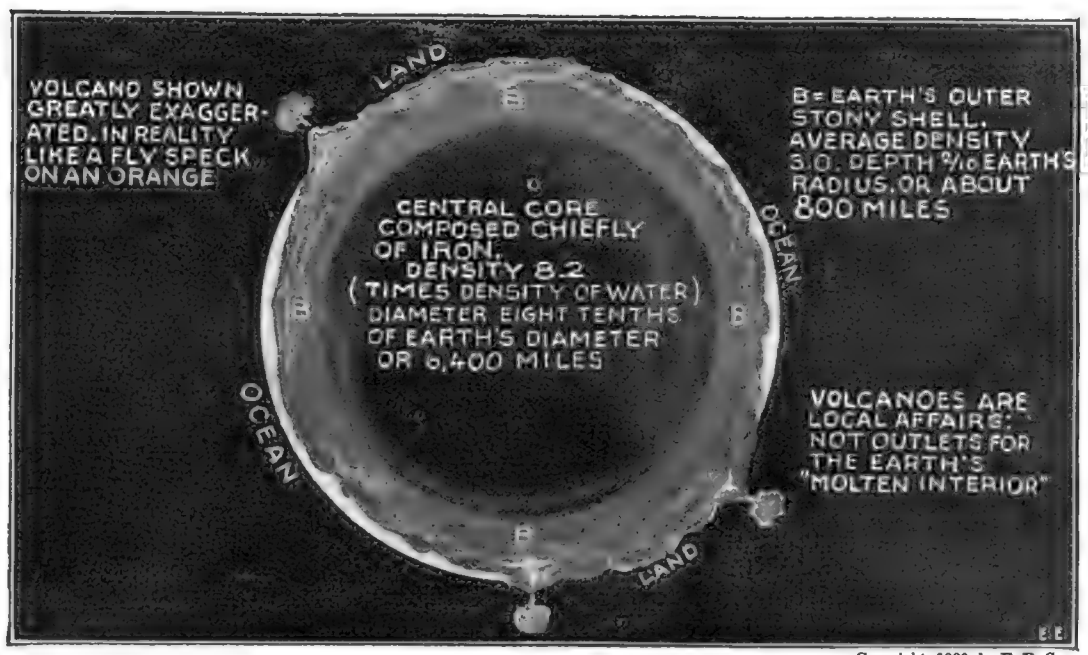
There is strong reason for believing that this theory approximates more closely to the truth. It is interesting in this connection to recall the fact that the meteorites, which are believed by some geologists to be shattered worlds, are either almost pure iron or else stony in their composition.

Whatever theory is held to it is evident that the earth's interior cannot be in a fluid state;—*tho locally at shallow depths and moderate pressures "pockets" of molten matter and gaseous vapors may occur.* Greatly increased pressures at lower depths would probably keep the material in a solid state even tho highly heated.

Further light is thrown on the problem by the important "pipe-tide" experiments of Michelson and Gale performed in 1913, for the purpose of determining how the earth yields to the tide-raising forces produced by the sun and moon. These experiments showed conclusively that the earth acts as an elastic solid and that it is as "rigid as steel"; a fact that is also borne out by various other experiments. This is in flat contradiction to the older theories of a "viscous" interior, the important distinction between a viscous and an elastic body being that the former after being deformed by a force does not return to its original form after the force is removed but remains permanently deformed while the latter returns to its former state when the disturbing force is removed.

Since the earth is shown to be "as rigid as steel" in its response to disturbing forces and moreover, since its highly magnetic state suggests the presence of a considerable quantity of iron in its interior, a substance that the spectroscope also show us exists universally to a great extent in the sun and stars, the theory that there is a *central iron core* to the earth is now very generally held.

Since the heavier metals mercury, gold and platinum, have densities greater than twelve it follows that they cannot occur in


VOLCANO SHOWN GREATLY EXAGGERATED. IN REALITY LIKE A FLY SPECK ON AN ORANGE
LAND
B=EARTH'S OUTER STONY SHELL. AVERAGE DENSITY 3.0. DEPTH 2/10 EARTH'S RADIUS, OR ABOUT 800 MILES
CENTRAL CORE COMPOSED CHIEFLY OF IRON. DENSITY 8.2 (TIMES DENSITY OF WATER) DIAMETER EIGHT TENTHS OF EARTH'S DIAMETER OR 6,400 MILES
OCEAN
OCEAN
VOLCANOES ARE LOCAL AFFAIRS: NOT OUTLETS FOR THE EARTH'S "MOLTEN INTERIOR"
LAND
E.E.

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Scientists Now Believe that the Earth's Interior Is Not Molten as Had Been Thought for a Long Time. From Many Scientific as Well as Mathematical Considerations, It Has Been Proven That the Interior of the Earth Is as Solid as Steel. Seemingly, the Inside of the Earth Is Not Hot at All, Most of the Heat Being Contained in the Crust of the Earth. It Is Now Thought That This Heat Is Produced by Radio-Activity.

any considerable quantity within the earth's interior.

An interesting point to consider in connection with the constitution of the earth's interior is the *Radio-activity* of matter found in its crust. Owing to the fact that tremendous amounts of heat are released by the disintegration of radioactive substances in the earth's surface crust it has been shown that these substances cannot exist within the earth's interior at a greater depth than about forty miles.

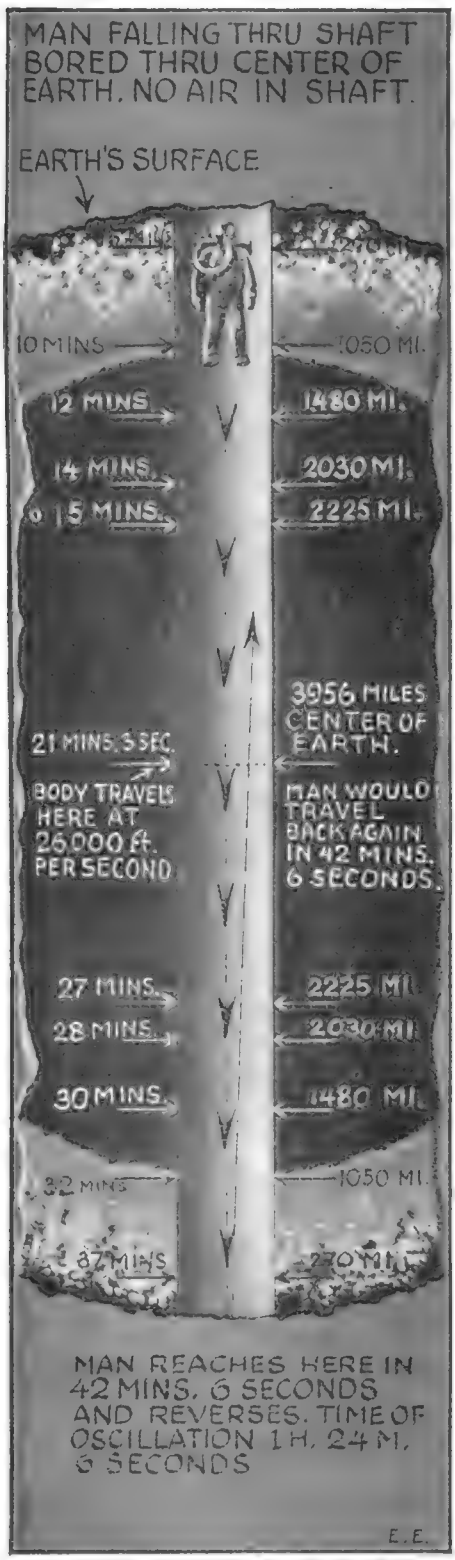
The average quantity of radioactive matter in the earth's surface rocks has been estimated. It is an extremely minute quantity but is so appreciable in its effect upon the heat of the earth that only one-twentieth of the amount found per cubic centimeter in surface rocks, if universally distributed thru the earth's interior, would keep the earth from cooling and lengthen the geological ages beyond reason.

The conclusion is forced upon us that the radio active substances of the earth must be confined to a very thin outer shell, or else, the earth is *gaining* heat.

In fact, the idea has been advanced that the observed heat of the earth's surface layers may be due to the radio activity alone and that the earth's interior may be comparatively cool.

It is the belief of certain scientists that there may be within the interior of the earth *endothermic compounds,* resulting from the union of helium and hydrogen with carbon and the metals, in which the stored up energy may be many thousand times greater, proportionally, than the energy locked up in our most powerful explosives.

Unexpected disturbances or perturbations of our planet from without might suddenly release the energy stored away in such compounds and cause a veritable world explosion such as might conceivably produce a *Nova* (New Star).



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This View Shows What Would Happen to You if You Would Fall Clean Thru the Center of the Earth if There Was a Vacuum in the Shaft Instead of Air. If You Carried Your Own Oxygen It Would Not Be at All Impossible That You Would Survive the Trip Because You Would Not Encounter Any Friction. It Would Take You One Hour, Twenty-four Minutes and Twelve Seconds to Make the Round Trip. In Other Words, Coming Back to the Starting Point.

"FALLING THRU THE EARTH."

In connection with a discussion of the condition of matter within the earth's interior it may be of interest to consider what would happen to a body falling down a shaft extending from surface to surface, *thru the very center of the earth.*

Three important factors affect materially the consideration of this problem: the *air resistance* within the shaft, the *rotation of the earth* about the polar axis, and the *decrease in the acceleration of gravity* beneath the earth's surface.

It is a well known law of physics that gravity is greatest at the surface and decreases within the earth so as to be always directly proportional to the distance of the point from the center of the earth.

Taking account of this decrease in the force of gravity with depth, we will first consider the case of a body falling in a vacuum, and therefore free from air resistance, along the earth's axis from pole to pole. In such a shaft there will be no deflection of the body arising from the earth's rotation since the rotation of the earth is performed about the polar axis.

It can be shown that a body starting from rest and falling along the polar axis *in vacuo* will reach the earth's center in $21^m\ 3^s$; its acquired velocity at the time it reaches the center will be 26,000 feet per second, or four and nine-tenths miles. With this as an initial velocity it will then pass from the center towards the opposite surface *against* the attraction of gravity, taking the same time that it took to fall from the surface to the center, or $21^m\ 3^s$. By the time the surface is reached its velocity will be reduced to zero and the body will then fall toward the center once more, which it will reach again in $21^m\ 3^s$. It will pass back from the center to the surface at the original point of departure in another $21^m\ 3^s$, and so on indefinitely. The motion of the body in this case is what is known as simple harmonic motion. Unless stopt by external forces a body would oscillate under such conditions from surface to surface, *forever,* the period of the oscillation being $1^h\ 24^m\ 12^s$. The velocity of the body and its distance from the surface can be found for any instant by means of a simple mathematical formula.

Consider now the effect of the earth's rotation on the fall of a body, *in vacuo, along any other axis thru the earth.*

It is well known that at the earth's surface a falling body is deflected by the earth's rotation to the *Eastward* by an amount that is proportional to the square root of the cube of the height of fall and to the cosine of the latitude. This deflection only holds for surface gravity, however, and for great depths we find a com-

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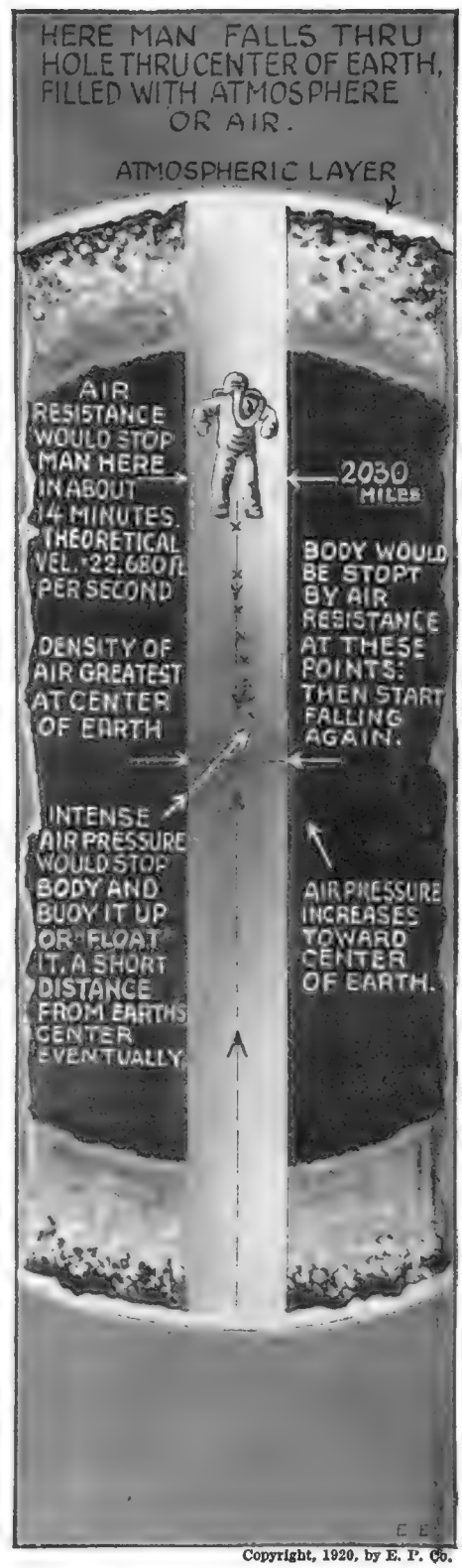
HERE MAN FALLS THRU HOLE THRU CENTER OF EARTH, FILLED WITH ATMOSPHERE OR AIR.
ATMOSPHERIC LAYER
AIR RESISTANCE WOULD STOP MAN HERE IN ABOUT 14 MINUTES. THEORETICAL VEL. 22,680 ft. PER SECOND
2030 MILES
BODY WOULD BE STOPT BY AIR RESISTANCE AT THESE POINTS: THEN START FALLING AGAIN.
DENSITY OF AIR GREATEST AT CENTER OF EARTH
INTENSE AIR PRESSURE WOULD STOP BODY AND BUOY IT UP OR FLOAT IT A SHORT DISTANCE FROM EARTHS CENTER EVENTUALLY
AIR PRESSURE INCREASES TOWARD CENTER OF EARTH.
E. E.

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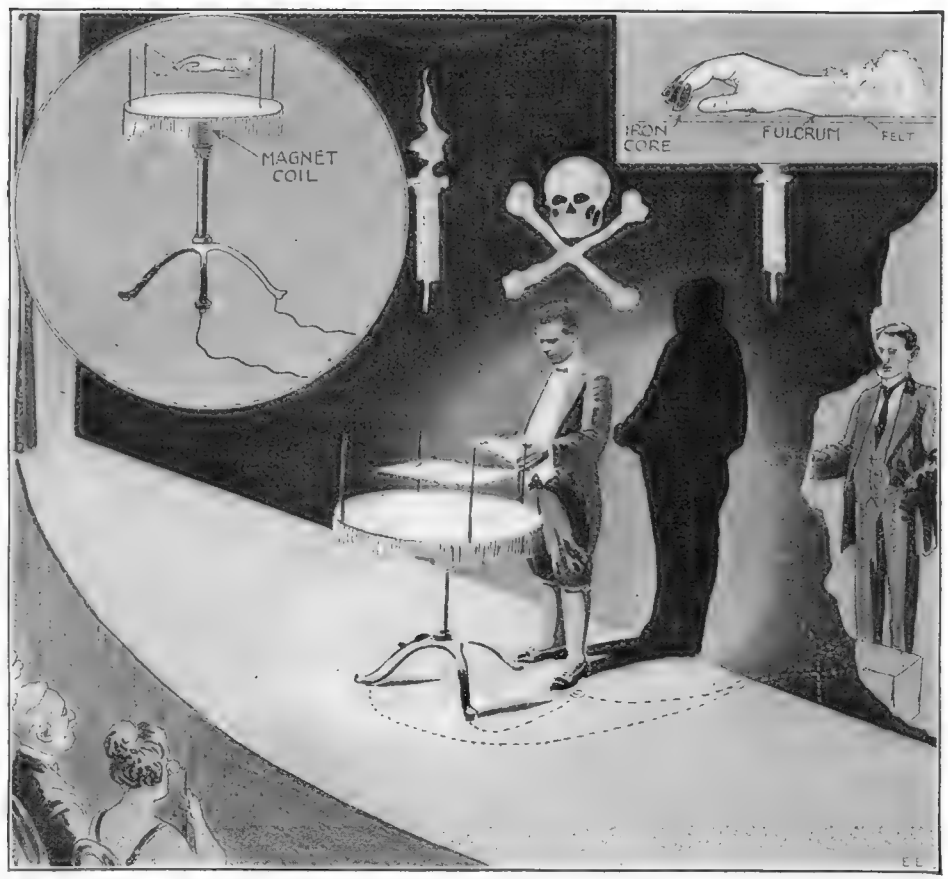
This is a Parallel to the Opposite Illustration, and Shows What Would Happen to You if You Were to Fall Thru a Shaft, Which, However, Contained Air. It is Interesting to Note That You Would Never Be Able to Fall Even Half Way Down for the Simple Reason That the Air at a Distance of About Two Thousand Miles Below the Surface of the Earth, Due to the Ensuing Compression, Becomes Almost as Thick as Molasses.

The Amateur Magician

The Rapping Hand

By JOSEPH H. KRAUS

PROFESSOR HARGRAVE had been very busy on some new research for quite a while and I couldn't find opportunity to see him as often as I desired, but as fate would have it we finally ran into each other, so to speak, at a New York playhouse where he had gone to meet an old friend of his, now entertaining the public with a "Magic Act."



The Home Magician Will Find the "Rapping Hand" Very Effective as a Mystery Producer. The Hand Is "Worked" by an Electro-magnet, the Circuit Being Closed by a Confederate, Usually.

A short time after this we were en route to his Long Island home again where he had "something new." "Now, old timer," he exclaimed, after we had made ourselves comfortable, "I have a little device here which has been *killed,* or practically so, by the magical profession. It is very clever and quite undetectable and will come in very handy, particularly now when the *Ouija Board, Spiritual Seances, Rappings,* etc., are being held so reverently. Wealth, sport and fun can be obtained from the same. Just to demonstrate," he continued, "you see here we have an ordinary hand made of wax or molded wax composition. Look it over and examine it carefully. You will note that there are no springs, wires, threads or in fact anything connected to it now or at any time.

"I take this hand and place it upon this glass plate, I allow you to select any card from the deck, you return it. There, that's fine! By placing the deck into this little black bag I can know the name of your card by only asking the operating hand what it was, using the same code that was used in the *Bell Trick* described some time ago. You will remember that two rings signified YES and one NO. You don't believe it? Well, just to demonstrate."

Professor Hargrave had now placed the molded wax hand upon the glass plate which he held about four inches above the table. Meanwhile adjusting four little wires at the ends of which were small hook-like formations passing thru holes in the corner of the plate so that it was suspended horizontally. At the other end the wires were attached to four posts screwed into the table. Then continuing to address the hand, he said, "Will you tell this gentleman by raps the number of spots which appeared on the card he had just chosen?" Immediately at the word of command the hand tapt out the answer, seven clear distinct raps, on the glass table.

I grapst for the hand, lifted it from the plate. There were no strings, no wires, or anything else connected to it. The Professor laughed at my chagrin in not finding something I had expected and again reached for the hand. Replacing this he readdrest the hand.

"Was that card a diamond?" The answer in the affirmative convinced me that it *was* a pretty good stunt.

I had seen too many of the Professor's tricks, however, to become extremely excited or marvel at the results, although they couldn't be described with the same effect that they have when presented. To see a hand and wrist lying on the table rap out an answer to any question you may ask of it, provided the answer can be given as either "yes" or "no," is an extremely wonderful bit of entertainment. The mystery then continued in the shape of a fortune telling stunt until my strained eyes refused to watch any longer. The Professor then took the hand off the glass plate, disconnected the latter from the suspending wires and placed it on the regular magician's table, where he was demonstrating his trick.

We then stept over to an adjoining library table, sat down and the Prince of Magicians busied himself with a fresh cigar. This tedious operation completed, he opened a drawer and leisurely extracted several sheets of paper and a pencil. Then laying these in front of him he proceeded to sharpen a pencil, another tedious operation, successfully completed after several *bad breaks.* "Well, now," Hargrave ejaculated suddenly, "I suppose you would like to know all about this, wouldn't you?"

Tap—tap—tap. Wheeling around quickly I noticed the hand on the table rapping out a regular rat—tat—tat in time with music with which a phonograph in a distant part of the house was permeating the atmosphere. "Well, I'll be ———. The hand stopt short. "Here, here," the Professor interrupted, before I had gone much further, "you will scare it." It started again; slowly at first, however, then with increasing rapidity until the sound was more like machine gun discharges than anything I have ever heard. "All right, that will do," Hargrave shouted in a commanding voice, and the hand, mysteriously affected, now quieted down.

"Now to proceed with the work in hand. You wanted to know how this was done. Well, here it is. You see it is very simple. That hand is simply an ordinary wax model procured from any store in the largest cities. It is sometimes used for demonstrating the quality of gloves and

(*Continued on page 74*)

In "JUNE" E. E.

How "Cartoon Movies" Are Made.

Psychopathia or Psychics—which? Does the Brain Interpret Radio Signals, or is This a Disease of the Mind? By H. Gernsback and Joseph H. Kraus.

Oddities of Sound—Part II. How the Phonograph Talks. By H. Winfield Secor.

Harnessing Brooks and Streams for Electric Light and Power.

Searchlight and Mirror Mark Aero Field. By Edwin F. Linder, M. E.

A Wartime Radio Detective. Episode II. By Pierre H. Boucheron.

A Miniature Sky—in which the stars and planets may be studied at will. By Robert H. Moulton.

The Aurora—Facts and Theories with exceptional illustrations. By Prof. Lindley L. Pyle, Dept. Physics, Washington University.

Radium—The "Bad Boy" of Science. Another popular article on Radium and its Wonders. By Harold F. Richards, M.A.

Another "scientific story" by Charles S. Wolfe.

Low Voltage Soldering Irons and How to Build Them. H. H. Parker.

Besides all the usual departments, including "Home Electrics"; "Everyday Mechanics"; "Electrical Machinist."

The Above Photographs Show Some of the Work Accomplisht and Also the Work-Shop of Mr. A. M. P. Cowley of St. Paul, Minn. As Mr. Reed Points Out In His Article, Mr. Cowley Has One of the Finest Laboratories In All "Bugdom." You Will Thoroly Enjoy This Story of Mr. Cowley, 66 Years Young, and "Dean of All the Bugs."

Some Laboratory!!

By THOMAS REED

WHAT was the first shop you ever had? Want to hear about mine? All right then, I'll tell you. I don't suppose I had accumulated more tools than a couple of "gimblets" and the family saw (used principally for cutting rings off hambones) before I felt the pressing need of a "shop," or "laboratory"—as you highbrows call it to-day, and began to prospect around the house for a location, like an old "Forty-Niner" looking for gold.

At first glance, the "prospect" looked like an embarrassment of plenty. The house I lived in was a big old house, with a main part, and an ell, and a sub-ell, and a shed, and another shed, tapering off that way to the point where the house ended and the back-yard began; and in all this space, there were many places which would have done admirably for a shop.

But when it came to "staking out" and taking possession of my claim, I found each spot occupied by some domestic object, firmly rooted in possession, and very difficult to dislodge.

For instance, there was a fine tho somewhat angular space under the cellar stairs; but it was stuffed with father's old books, and as to displacing them—well, you could have displaced father's liver with considerably less pain on his part.

Then there was an available corner over behind the furnace, but that was the asylum for discarded "crocks." The collection of crocks came about in this way: sometimes they break, leaving a cover on your hands, and sometimes a cover breaks, leaving you a crock. Now you'd think it was an easy problem, simply to combine the left-over covers with the ditto crocks, like widows marrying widowers—as they sometimes do when susceptible bachelors are scarce; but a widowed cover was never known to fit a bereaved crock. It either tilted up at an angle, or went down thru altogether.

So there those odd crocks were, stacked up in rows, in the forlorn hope that sometime or other a fit would occur. They retarded the growth of Science like anything, by occupying the space I needed for my "gimblets"; but throw them away?—well, you didn't know father, of course. It's true, I proposed the throwing, in loud and distinct tones; but, as I may have said somewhere else, the weight of my suggestions wasn't exprest in tons, or pounds even, but more like these atomic weights, that use up a long string of decimals, such as .000000001. That was about where they stood in the family scale of specific gravities; so the crocks stayed.

Never mind, out under the "sub-el" I have mentioned was a large empty room, with big windows letting in the sun, and even a bench all ready for use. Well, what more did I want? Why didn't I take that? I did, because it was all I could get.

But oh, oh, likewise—ah, ah,—as they say in comic opera, it was the laundry, or "washroom" as we called it; and when Monday arrived—Daddy!—it was no place for "gimblets" and hambone-saws, let alone my "delicate" mechanisms under construction. Clothes-baskets were there, tubs, spattering water and clouds of steam, not to mention the heavy and indiscriminate feet and hands of the big Swede engaged in the separation of dirt from duds. Each Sunday I had to gather up and remove to "zones of safety" all my various treasures, down to the last corset-spring.

But as I advanced in age and sassiness, my shop-requirements obtained a tolerance, and at last a regular standing. Having routed the crocks, my next bold move was on the space over by the window, dispossessing the old packing-case, on which we

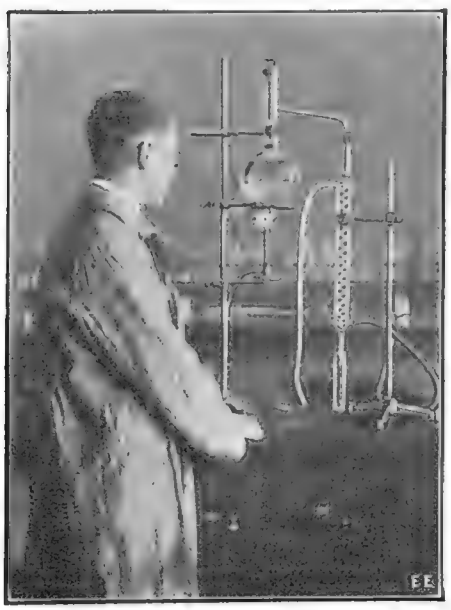
(*Continued on page* 89.)

Practical Chemical Experiments

By PROF. FLOYD L. DARROW

EXAMINATION OF WATER—I.

THE chemical examination of water is a matter of very great importance, both for sanitary and industrial purposes. Is water pure and wholesome to drink? Has it suffered contamination from sewage, sinks, or products of



Using the Vertical Condenser for the Distillation Water in the "Ammonia Test."

organic decay? Is it free from mineral matter objectional to particular industrial uses? Is it hard or soft? Does it contain poisonous metals dissolved from the pipes thru which it has past? These and many more questions of a similar nature must frequently be answered by the chemist, but to be able to give trustworthy advice in these matters he must exercise the utmost skill and thorogoing care at every point.

SANITARY ANALYSIS OF WATER.

Taking the Sample: The first source of probable error comes at the very outset. Very frequently a chemist is asked to analyze water without any knowledge of its source. But this is all wrong. The person who makes the analysis should take the sample and in so doing note very carefully all the surroundings—nearness to buildings, slope of the land, nearby surface conditions, proximity to fertilized fields, etc. Such information is of the utmost importance in interpreting results and without it intelligent conclusions cannot be drawn.

Making the Determination of Total Solids by Evaporation Over a Copper Water Bath. Desiccator Stands at the side.

In the second place the sample must be taken in a *chemically* clean bottle of at least a half gallon capacity. To cleanse the bottle fill it one-third full of a solution made by dissolving potassium bichromate crystals in concentrated sulfuric acid. Allow this solution to stand in the bottle for several hours, shaking at frequent intervals so as to bring it in contact with every part of the inside of the bottle. Then pour out the solution, preserving it in a glass-stoppered bottle for future use and rinse the bottle thoroly. Go to the place where the sample is to be taken and fill the bottle with the water in question. Empty this out completely and fill the bottle again. Stopper it tightly and take it to the laboratory where the analysis should begin at once.

For all solutions and wherever water is used in this work other than that under examination, distilled water must be had. It will be found very desirable, both for this and subsequent work to have in your laboratory a small *water still.*

Sediment: The presence of sediment will not tell much as to the character of water, yet it is desirable to make this test. Allow a test tube full of the water to stand over night, or if you have a *centrifuge* such as is used in the Babcock milk test, centrifuge the sample. Carefully pour off the clear liquid and if there is a residue examine it with a hand magnifier or better still with a compound microscope. If the sediment should disclose bits of hair and cotton or woolen fibers, it might indicate organic contamination.

Determining the Quantity of Organic Matter by Titration With Potassium Permanganat, Accompanied by heating and Stirring.

Color: Fill a long test tube, or preferably a Nessler tube, with the water and stand it on a piece of white paper in front of a window giving a good light. Back of the tube place a piece of white paper extending almost to the bottom of the tube. If on looking down into the tube the water is transparent, or shows only a slight bluish tinge, it is normal in color. If, however, there are tints of brown, yellow or green, the water may be polluted.

Odor: Perfectly harmless water may have both odor and taste, while exceedingly dangerous water may be free from both. However, the presence of a positive odor usually indicates contamination. To determine the odor, warm about 250 cc. of the water in a corked flask to 40° C. After shaking well, remove the stopper and smell the contents. If the odor is putrid, the presence of decaying organic matter is indicated. This may be of either animal or vegetable origin.

Total Solids: By total solids is meant the residue of mineral and organic matter left upon evaporating water to dryness. If you have a balance, this determination may be made quantitative. Such a balance, too,

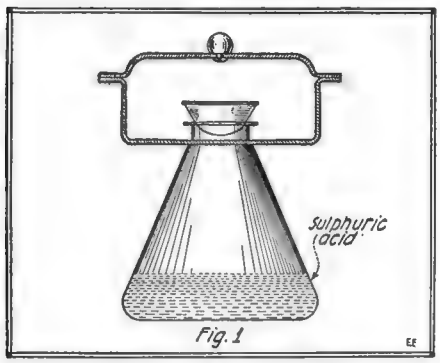
Drying the Residue of Total Solids, Preparatory to Cooling in the Desiccator and Weighing.

will be found exceedingly useful in many other branches of experimental chemistry work. For many determinations a balance is indispensable. Of course, an analytical balance is desirable, where possible, but a less expensive one, that will weigh accurately to a milligram, will satisfy the requirements of most of this work.

Measure exactly 100 cc. of the water into a clean, dry evaporating dish, which you have previously weighed to the nearest milligram. Evaporate this to dryness over a copper water bath. Dry for an hour at 105° C. in a small drying oven placed on a tripod over a Bunsen burner. Then cool in a desiccator over sulfuric acid and weigh. See Fig. 1. Subtract from this second weight the original weight of the empty evaporating dish and calculate it as milligrams. This number multiplied by 10 will give the number of parts per million of total solids in the water. For drinking purposes water should not contain more than 600 parts per million.

To determine the presence of *organic matter* evaporate to dryness another portion of 50 cc. of the sample in a porcelain dish.

Making the Chlorin Determination by Titration With Standard Silver Nitrate Solution and Potassium Chromat Indicator.



Chemical Laboratory Desiccator Used for Drying Precipitates.

When dry place the dish over a Bunsen burner and heat gently at first, gradually raising the temperature. If the residue chars and blackens, organic matter is present and raises the suspicion of contamination.

DETERMINATION OF CHLORIN.

By *chlorin* we mean combined chlorin. This element in itself is not at all harmful, but if present in more than small quantities, it indicates sewage contamination and is, therefore, tested for with great care.

For this determination a standard *silver nitrat solution* will be required. Prepare this by dissolving exactly 2.394 grams of pure silver nitrat in a liter of distilled water. A solution of 10 grams of potassium chromat in 100 cc. of water will be necessary for an indicator.

By means of a pipette transfer 50 cc. of the water to be tested into each of two small beakers. To each add three or four drops of the potassium chromat solution. Fill a burette with standard silver nitrat solution and mount it over the beakers placed in a good light on a white paper. Now add the silver nitrat a drop at a time, stirring after each addition with a clean glass rod, which must not be removed from the beaker. Continue this procedure until the water shows the first tinge of red. To determine when this occurs, look at the water thru the contents of the second beaker placed at one side. From the readings of the burette find the number of cubic centimeters of silver nitrat solution that have been used. Each cubic centimeter used means 10 parts of chlorin per million parts of water. In exceptional cases the chlorin content of pure water may run as high as 50 parts per million, but it is usually much lower. A large amount of chlorin indicates contamination from sewage or sinks, unless there is some other known source.

DETECTING THE PRESENCE OF AMMONIA.

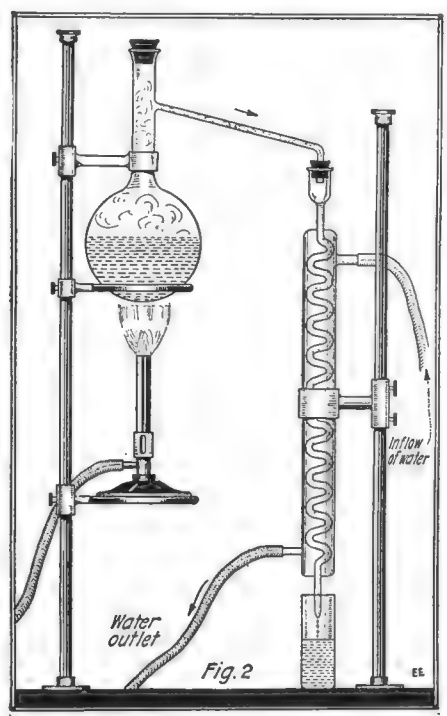
The presence of nitrogen compounds in water, of which ammonia is one, is always regarded as a sure sign of contamination.

Nesslerizing Water in the Ammonia Determination. Nessler's Reagent Is Being Introduced With a Pipette.

For nitrogen can come only from animal and vegetable sources, and while these nitrogen compounds in themselves are not harmful, they are frequently accompanied by germs of contagion, which breed disease and death.

First of all it must be emphasized *that these tests cannot be carried out in a laboratory containing any ammonia bottles or ammonia solutions.* They are exceedingly delicate tests and the presence of ammonia in the air will give a positive test, when perhaps the water originally contained no ammonia at all.

The solution used in these tests is called *Nessler's Reagent* and is made as follows: Dissolve in 250 cc. of water 62.5 grams of potassium iodid. Pour out 10 cc. of this solution and save for future use. To the remainder add a cold, saturated solution of mercuric chlorid until a permanent precipitat appears. Redissolve this precipitat with the 10 cc. of potassium iodid solution saved out and again add mercuric chlorid very slowly, until a slight precipitat remains after stirring. Add a water solution of 150 grams of potassium hydroxid and make the volume up to a liter. After the precipitat has settled, pour off the clear liquor and preserve in a clean stoppered bottle.



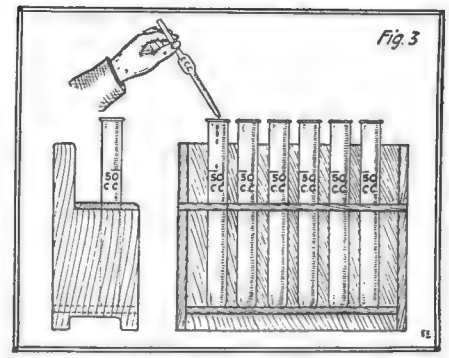
Distilling Apparatus Set Up for Making Ammonia Tests on Water. The Work Is Extremely Interesting and Practical, as It Concerns Our Daily Health.

Making the Ammonia Determination: Ammonia is usually reckoned as "free" and "albuminoid," but for our purposes the test for the total ammonia content is all that will be required.

To liberate the ammonia from the nitrogenous compounds in the water an alkaline solution of potassium permanganat is essential. To make this solution dissolve 100 grams of potassium hydroxid and 4 grams of potassium permanganat crystals in 625 cc. of distilled water and evaporate in a porcelain dish to 500 cc. Preserve this in a stoppered bottle.

Now set up distilling apparatus similar to that used in the distillation of alcohol, or better use a vertical condenser with a spiral condensing tube, like the one shown in the cut, figure 2. If possible use a liter boiling flask and close its neck with a tight fitting cork stopper—not rubber.

First place in the flask 200 cc. of *distilled* water and add 50 cc. of the alkaline potassium permanganat solution. Distil off three successive portions of 50 cc. each to free the apparatus of any traces of ammonia compounds that may be in it. Then add a half liter of the water to be tested and distil off into Nessler tubes, or tall test tubes, six portions of 50 cc. each. See Fig. 3. To each portion add 3 cc. of Nessler's reagent by means of a pipette and after waiting five minutes look down into the tubes. A yellowish brown coloration proves the presence of ammonia. The amount of ammonia may be judged from the depth of color. If considerable amounts are present a brown precipitat will separate out. If more than a faint trace of yellow is observed, contamination is certain. Practically all of the ammonia will be found in the first four tubes.



Rack of Test Tubes, Each Holding 50 C.C., Used in Nesslerizing Water. Nessler's Reagent Is Added by Means of a Pipette.

DETECTION OF NITRITES.

Nitrites represent another form of nitrogen compounds, whose presence also indicates contamination. In fact nitrites are never found in good water. One of the highest authorities on water analysis states that more than one part in 500 million parts of water is looked upon as unfavorable.

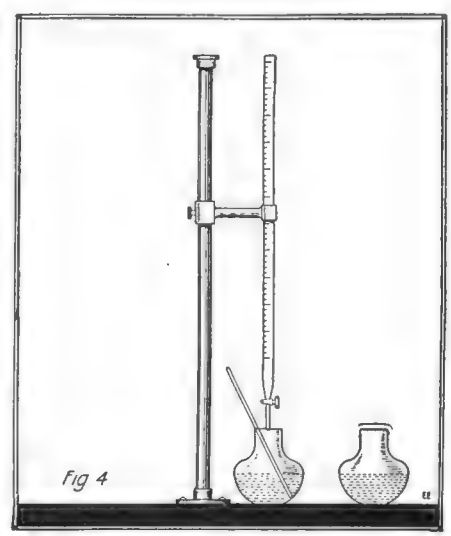
For this very delicate determination two solutions will be required as follows:

Sulfanilic Acid: Dissolve 1 gram of acid in 100 cc. of hot water and preserve in a stoppered bottle.

Naphthylamine Hydrochlorid: Boil one-half gram of the salt in 100 cc. of water for ten minutes, make up to 100 cc. and preserve.

The Nitrit Test: In a Nessler tube place 50 cc. of the water to be examined and add 1 cc. of concentrated hydrochloric acid followed by 2 cc. each of sulfanilic acid and naphthylamine hydrochlorid. Cover with a watch glass and allow the tube to stand for 30 minutes. If a pink color is found either immediately or at the end of the above period the presence of nitrites is proved.

(*Continued on page 77*)



Titration Apparatus Used in Testing Water in the Chemical Laboratory.

A Bench-Lathe From Pipe

By A. NOAH HARRINGTON

HEREWITH present drawings of a hand-made bench lathe made from pipe fittings. I made one several years ago, and it has given such good service that I thought some of the readers of the ELECTRICAL EXPERIMENTER would be interested in constructing such a lathe. The materials required are five one-inch crosses or double tees, five tees, two ells, four feet of one-inch shafting, ten nipples, four floor plates and a small amount of babbitt metal. The drawing needs but little explanation; E and E in Fig. 1, are pieces of one-inch shafting fastened in the fittings with babbitt. Great care must be taken to get the two pieces of shafting *perfectly parallel!* If they are not, the slide rest and tail stock will bind, and you will not be able to slide them along the shafts smoothly.

The best way to do this, is to cut two pieces of metal exactly the same length and fasten them between the shafts at dd and ee, Fig. 1. Tie them together with the *slide rest* and *tail stock* in place. Wrap one layer of thin tissue paper around the shafts where they go thru the slide rest and tail stock so they will not bind and babbitt them in the pipe fittings. The nipples should be plugged with wood so the babbitt will not run into them. The ends of the shafts should be *tinned* with solder to hold them firmly in place.

The feed screw is made from a piece of one-half inch shafting threaded its entire length. Holes are bored in the nipples at L and MN. A one-half inch nut is placed in the nipple at M, figure 1, before the babbitt is poured for the feed screw to run in. Two collars can be cut from a piece of ⅜ pipe, and fastened on the feed screw each side of the nipple at LK, figure 1, with pins past thru the feed screw. A handle can be made from a pipe floor plate.

To make a good job of it, the lathe should be completely put together and carefully lined up with the feed screw in place, and then babbitted. The ends of the shafts should be firmly fastened in the fittings. The shaft for the head stock is made from a piece of one-half inch pipe turned smooth. One end is threaded for one inch, a one inch lock nut being screwed on, leaving three-quarters of an inch of thread projecting, to screw the face-plate on. The lock nut is turned down smooth to form the thrust bearing C, figure 1. The iron face-plate was cast from a wooden pattern and turned up in the shop.

But a very good one can be made from a large pipe floor plate or base flange. The slide rest is shown in figures 2 and 3. J is a plate of iron 3½ x 7 inches. A pipe floor plate is fastened to it at H, Fig. 2; DD, are pieces of one-half inch cold rolled

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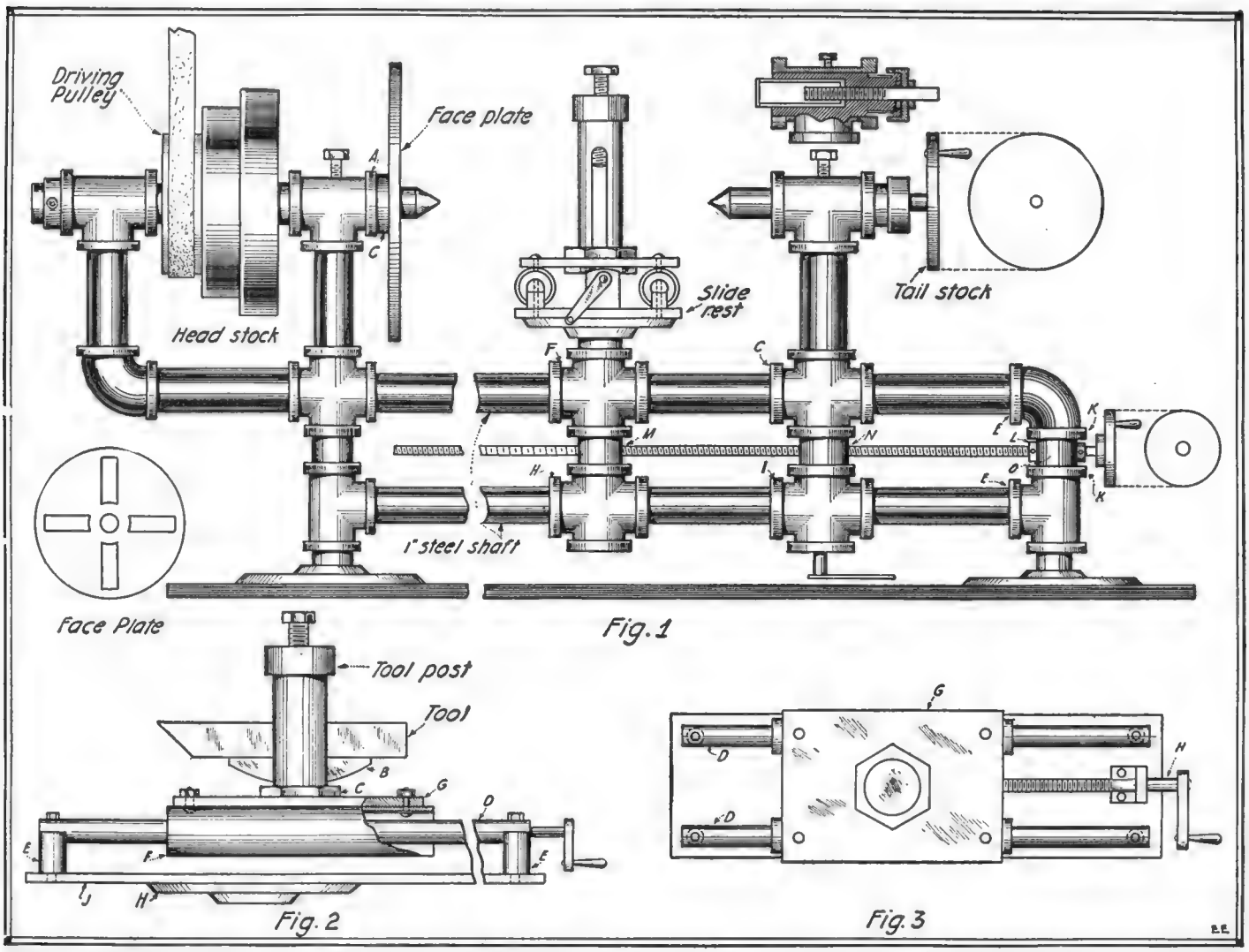


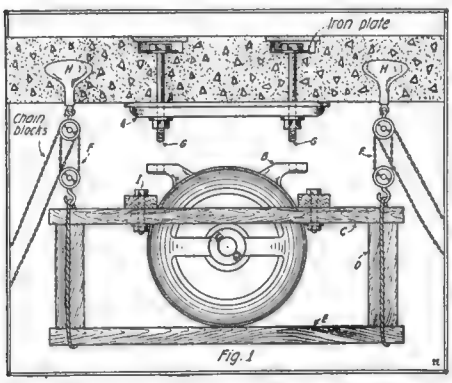
A Surprisingly Useful and Accurate Bench Lathe Can Be Built from Iron Pipe As Here Illustrated. The Guides On Which the Tool Carriage Move Are Preferably Made of Machine Steel, but Iron Pipe, Carefully Polished, Can Be Used for Rough Work.

The Electrical Machinist

By H. WINFIELD SECOR

No. 7—ERECTING MOTORS (Cont.)

IT is comparatively easy to erect and properly secure in place small motors and dynamos, but larger machines are sometimes quite awkward to erect, especially when they are placed on the ceiling. A scheme used in an installation



This Illustration Shows Wooden Cradle In Which Large Electric Motors Were Raised by Means of Chain Blocks, to Their Position Against the Ceiling on Which They Were to Be Mounted. Of Course, There Are Many Other Ways In Which This Can Be Done, but This Idea Worked Out Very Well, and Twenty-four 50 H.P. A.C. Motors Were Raised In This Manner, Without a Single Mishap.

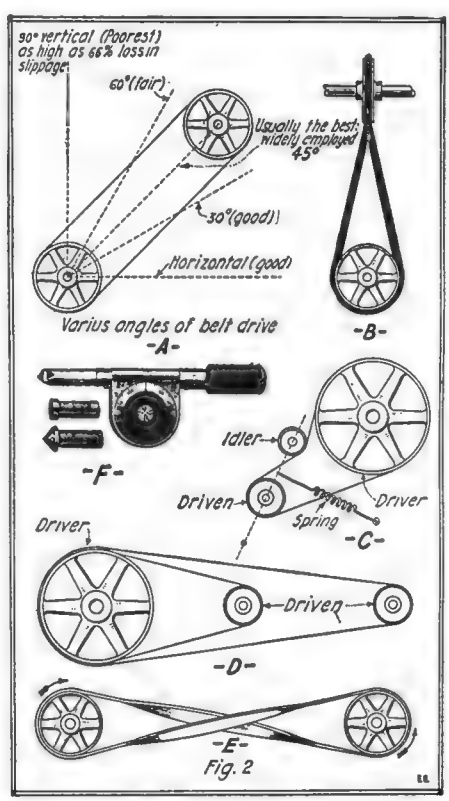
of high-powered motors, comprising twenty-four 50 H.P., two phase, A.C. induction motors, is illustrated at Fig. 1. The conditions for erecting these motors were as follows:

The building was a solid concrete one, with concrete floor beams and at first it looked as if the construction gang would have to build a heavy timber frame or scaffold to support the chain blocks in order to raise the motors to the ceiling so that they could be bolted into position. However, it was presently discovered that the designers of this building had had the forethought to have a series of threaded iron sockets molded into the concrete beams on the ceiling, at intervals of about eight feet, for the purpose of erecting machinery, mounting shafting, etc.

The first step then taken was to have four wrought iron (or steel) screw-eyes made, as shown at H. These were forged by a blacksmith from some 1" diameter stock, the loop of the eye being firmly welded to the shank and the latter threaded, of the proper pitch to screw into the sockets before mentioned.

The next problem met with, and which proved to be not so easy as first appeared, was how to raise the motor in the inverted position. First, of course, the end frames and bearings were inspected to see that they were properly reversed with respect to the oil wells and ring oilers in the bearings, for proper operation in this inverted position on the ceiling. Practically all motors of the small or medium size are reversible by simply removing the bolts holding the bearing frames and rotating these half way around, so that the bearing oil drain comes at the bottom for the new position. Eventually, the problem was solved by procuring several joists of substantial size measuring 4"x4", and a cradle was made as shown at Fig. 1. The oil was emptied out of the bearings if there happened to be any; the motor was rolled over until its base feet turned upward in the air, and by means of a rope sling, secured around the feet or otherwise, the motor was raised by one of the chain blocks and the cradle slipt under it. The motor was lowered into the cradle, and this latter, prepared to be raised by means of the two chain blocks shown. Heavy rope slings about 1½" thick were past around the ends of the cradle, which was bolted together and the chain blocks attached to these ropes in the manner indicated. The iron screw-eyes are shown at HH, the chain blocks at FF, the iron bed-plate of the motor at A, and the bolts to hold the latter as well as the motor passing thru the concrete floor at GG. The frame of the cradle is shown at C, D and E. At II are shown two cross pieces of timber which can be put into place, after the motor is lowered into the cradle, so as to keep it from moving.

Careful measurements have to be taken in any cases such as these, so as to make sure that the chain blocks would always pull up to their maximum extent, i. e., with the two sheave blocks close together, so that the cradle could be raised sufficiently high in order that the feet of the motor will go into position over the bolts. The bolts for holding the motor were made of steel 1½" in diameter, machine threaded on the lower ends, and having extra large heads forged on them at the top. These pass thru the concrete beam 18" thick, and on the floor above, in the pockets in which the heads of the four bolts rested, there were afterward placed pieces of flooring tightly fitted in. The bed-plate A, weighing about 150 lbs., was raised into position and secured by lifting it up on to a heavy scaffold by three men, altho two were able to raise this from the scaffold and lift it up to a height even with their shoulders, and the nuts quickly placed on the bolts, this temporarily holding the bed-plate in position. The scaffold was then removed and the motor prepared for raising, in the cradle shown.



Here We Have Some Useful Wrinkles on Belt Drives. The Relative Efficiencies of Belt-Driven Shafts, Especially In Various Angular Positions Are Shown at A; a Reversed Drive With a Crost Belt Is Shown at E.

When the motor had been raised almost to a level with the ends of the protruding bolts, two of the nuts at one end were carefully removed, and standing on the scaffold which had been pusht up alongside the motor cradle, pressure could be

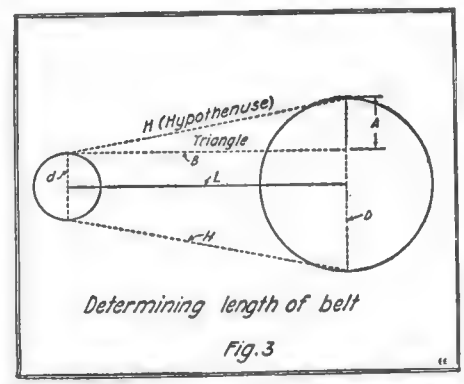


Diagram Showing the Various Mathematical Factors Used in Solving Belting Problems, Particularly That of Calculating the Exact Length of Belt Connecting Two Pulleys, Having Different Diameters.

exerted on the bed-plate, while the nuts were removed and two of the motor feet quickly pulled up over the bolts, by means of the chain block. Pressure could be exerted, if desired, against the bed-plate by blocking placed between the motor and the bed-plate. Behind each nut was placed a powerful spring washer which served to act as a nut lock in order to prevent them from vibrating loose. After two of the motor feet had been slipt over the bolts and the nuts taken up a few threads, the other two nuts were removed from over the bed-plate, and the remaining two motor feet slipt over the bolts. The nuts and spring washers were then placed on the bolts, and now all of the nuts were made up solid by heavy wrenches, locking the motor firmly in position.

After the cradle had been lowered and the chain blocks removed, the pulley was then placed on and the electrical connections from the motor to the controlling compensator box on a nearby concrete column were then installed. Everything was then ready for the connecting of the line shafting by means of a belt to the motor pulley. These motors were all placed safely in position without one accident in this fashion and the height of the ceiling was approximately 18'.

VARIOUS FORMS OF BELT DRIVE.

At Fig. 2, several forms of belt drives are illustrated. Connecting motors with line shafting or separate machines is commonly effected by means of leather, canvas or rubberized fabric belting (usually leather); also there has come into considerable favor in later years the well-known chain drive and various forms of gear and friction drives.

At Fig. 2A several important considerations in applying leather or other forms of frictional belt drives are indicated. Probably the greatest majority of belt drives are installed to operate at an angle of from 45 degrees to an angle of 60 degrees from the horizontal. Those interested can look up some of the efficiencies of various belt drives placed at different angles, in machine shop text-books and manuals. Some prefer the horizontal drive. Here the frictional

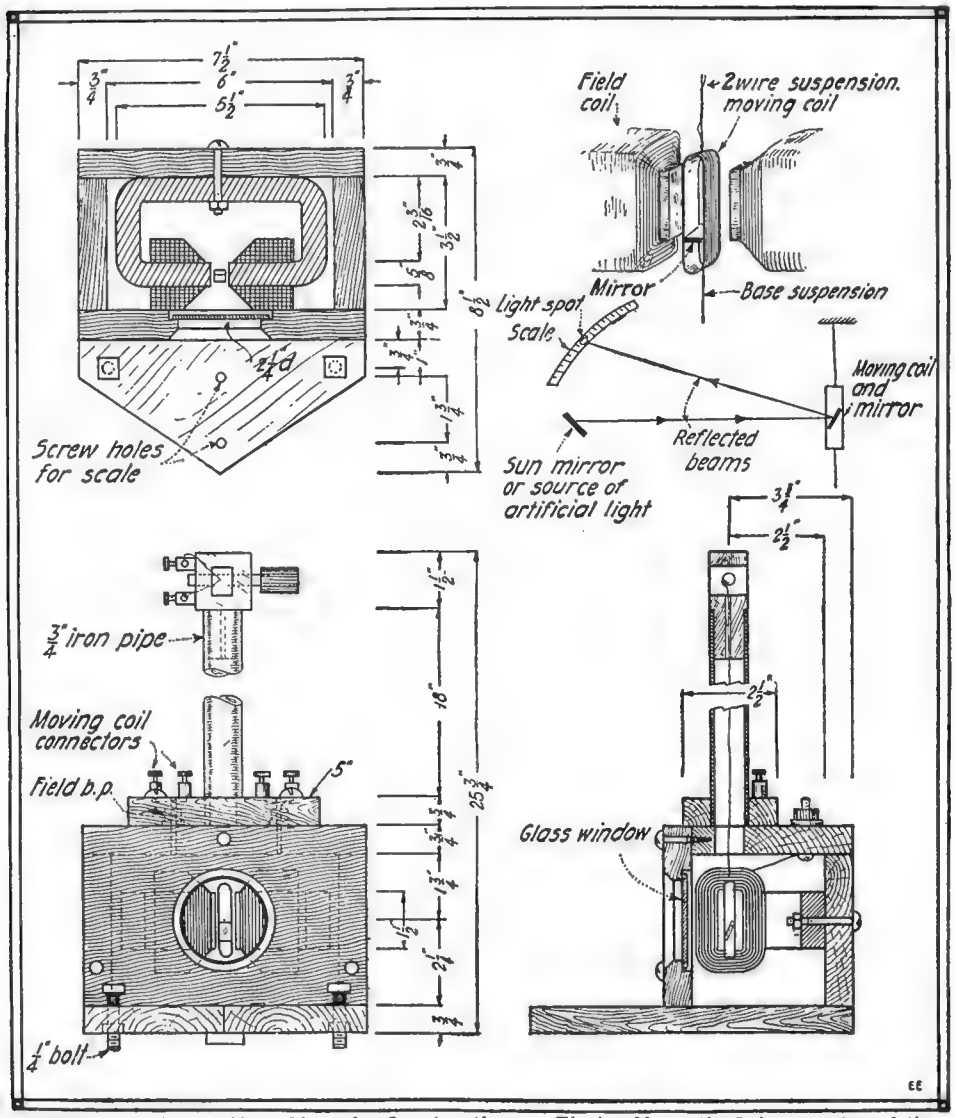
(Continued on page 82)

An Electro-Magnetic Galvanometer

By HANS O. STORM

A Moving Coil, Variable Field Instrument of High Sensibility

DRAWINGS are here shown of a D'Arsonval galvanometer constructed by the writer, which has certain advantages from the point of view of the amateur who wishes to make his own instrument. It operates on the same principle as the standard D'Arsonval galvanometer. A light coil, carrying the measured current, is suspended by its own lead-in wires in a strong magnetic field, and is deflected in proportion to the measured current. A small mirror attached to the coil reflects a beam of sunlight or artificial light upon a suitable scale, the observed spot of light being deflected from its neutral position on the scale by twice the angle thru which the coil is turned. The instrument here shown varies from the usual type in having electro-magnets in place of the permanent magnet, for furnishing the field in which the coil is suspended.



Complete Details Are Here Given for Constructing an Electro-Magnetic Galvanometer of the Moving Coil, Variable Field Type. It Possesses Very High Sensibility, and Is Used In Conjunction with a Beam of Light and a Scale.

This makes for greater ease of construction, since good permanent magnets of the proper shape are hard to make. The use of an electro-magnet also makes possible a stronger magnetic field around the moving coil. Furthermore, both the damping and the sensibility can be changed at the will of the operator by changing the current in the field coils. When using the galvanometer with a Wheatstone bridge, much labor can be saved by making an approximate adjustment without any current in the field coils of the galvanometer, then turning on the field current and making the finer adjustment.

The case of the instrument is made of wood, and serves both as a frame for holding the magnet and coil support, and as a cover to protect the moving coil from the disturbing effect of air currents. It is supported on three legs. The rear one of these is a small wood or fiber block glued to the base; the two front ones are bolts which turn in nuts countersunk into the wood of the base. Turning these bolts enables the instrument to be adjusted for level.

The window in the front of the case should be of the thinnest and clearest glass obtainable, for the beam of light must pass thru it twice before being thrown upon the scale.

The magnet core can be forged out of wrought iron, and should be well annealed. No finish is necessary except on the pole faces, which should be filed flat, or even a little concave, to make the flux-density in the air gap more uniform.

The winding of the electro-magnet depends upon the nature of the power supply from which it is to be excited. The best source of power is a storage battery, because it gives a steady E. M. F. Pulsating current from a rectifier will do, if the effective voltage of it remains constant. The coils in the galvanometer illustrated were wound with No. 22 enameled wire, 500 turns on each leg of the core, and all turns in series. It operates well on 15 to 20 volts. If a higher voltage is used, smaller wire and more turns should be wound, and vice versa. The coils are wound as near the air gap as possible, so that unavoidable magnetic leakage shall not weaken the field at that place. They must be tapered toward the air gap, in order that they may not obstruct the path of light from the mirror to the extreme end of the scale.

The suspension column is made of ¾" brass pipe or fiber tubing, firmly fitted and glued into a piece of wood at the base of it.

The coil support shown in the drawing enables the moving coil to be adjusted both for height and for angle. It is made of wood. The lead-in wires from the moving coil are wound around the horizontal wooden pin, which can be turned to adjust the height. The entire block can be rotated in the pipe to adjust for angle. A piece of flat spring steel, bent slightly so that it presses against the inside of the pipe, and resting in a groove in the coil support block, keeps the latter tight in the pipe, but not so tight as to prevent free adjustment. Flexible wires connect the coil support to rigid binding posts on the top of the case. With this arrangement any number of interchangeable moving coils can be used.

To make the moving coil: Bend a thin strip of brass into the shape shown. If a strong damping is desired, solder it together, if otherwise, glue it together with paper insulation between. Wind this frame with about 300 turns of the smallest silk-covered wire obtainable; at least No. 40. Fasten the final turns with a drop of sealing wax, and twist the free ends together. These serve for lead-in wires, they support the coil, and they furnish the controlling torque. Note that the fineness of the wire affects the sensibility in two ways; the finer the wire the more turns can be wound on the coil, and also, the weaker will be the controlling torque. Thus the sensibility will vary about as the square of the cross section of the wire, or as the fourth power of its diameter.

A piece of mirror is cut to fit the inside of the coil frame. This mirror will be about ¼" square. It is pushed in, and should stay there by its own friction, without glue. If this is the case, its angle can be adjusted to reflect the beam of light on to the scale from any desired angle of incidence.

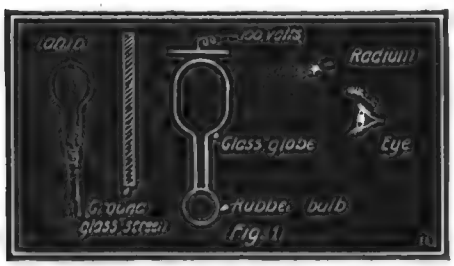
The scale may be of stiff paper on a wooden frame, and held about thirty inches in front of the instrument by a wooden arm, screwed to the base. In this case the

(*Continued on page* 114)

Radium--The Mother Of Ions

By HAROLD F. RICHARDS, M. A.

IMAGINE an insect so small that one-thousand billion of his brothers would have to be collected at one point in order to make a speck visible to the eye. The well-known cootie is as large as a prehistoric mastodon in comparison. Sup-



Apparatus to Show the Condensation of Water Vapor Upon the Ions Produced by Radium Rays In the Air Inside the Glass Globe.

pose further that this insect can move with a speed 3,000 times greater than the muzzle-velocity of shells thrown by the giant Berthas that bombarded Paris at a distance of 70 miles. It seems that it would take more than a Sherlock Holmes to track this elusive fugitive in its flight. Yet it is a task of the same magnitude that scientists have accomplisht in following the path of a *single alpha particle* thru the air. The following experiment, however, is so simple that it can be performed by almost anyone, after a few trials.

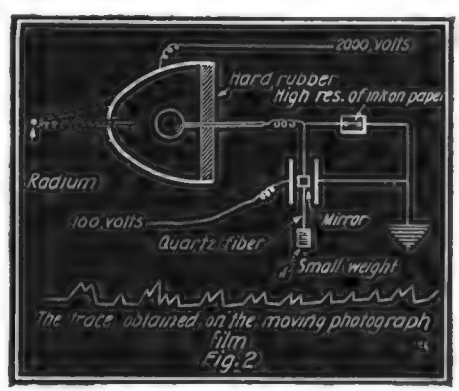
Science has far more sensitive means for detecting electricity than for measuring matter. I have already described, in a former article, (see March number), methods for detecting the particles of matter expelled when the atoms of radium explode. These methods operated by virtue of the electrical charge carried by these minute particles. Now I want to explain a simple experiment which enables us to follow, *by mechanical means,* the path of one lone alpha-particle. The apparatus is indicated in the illustration, Fig. 1. It consists simply of a hollow glass sphere to one end of which is attached a rubber bulb. Behind the glass globe is a ground-glass screen, thru which a powerful electric lamp sends a diffused illumination. When the rubber bulb is comprest and then suddenly released, minute drops of water vapor condense upon any dust particles which may be present, on account of the sudden lowering of temperature due to expansion. After this process has been repeated a number of times, all the dust nuclei have been removed from the air, and no clouds of condensed vapor are seen when the air is allowed to expand suddenly. Now place a bit of radium so as to send its radiation thru the air in the glass, and release the comprest rubber bulb. Fine lines of condensed water vapor are seen threading the air in the bulb. These show the presence of the alpha-particles.

The explanation of the effect is as follows: When the air is bombarded with alpha-particles, some of the molecules of air are broken up into electrified ions, very much as machine gun bullets might knock out individual grapes from bunches hanging on a vine loaded with the fruit. These electrified bits of sub-molecular matter act as nuclei for the condensation of water vapor. As the alpha-particle proceeds thru the air, it leaves a wake of ions in its path, and the vapor which has condensed upon them renders the path visible. Condensation occurs for the negative ions when the volume of air is suddenly increased by 25 per cent, but an increase of 31 per cent is necessary to cause condensation on the positive ions.

The fact that the drops of water are condensed about electrified nuclei is readily shown by placing two charged metal plates near the glass globe. The drops of water are then seen to move towards the plates, impelled by electrical attraction. This simple experiment can also be performed with *uranium,* which is comparatively cheap, or the ionization can be produced by X-rays or ultra-violet rays. The beta-rays and gamma-rays of radium will go right thru the glass wall of the globe, but if it is desired to work with the alpha-particle of radium or uranium, a thin paper window should be fitted in the wall of the globe, in order to let them thru. If a photographic plate is substituted for the eye, an actual trace of the alpha-particle can be obtained. It appears as a jagged line on the film.

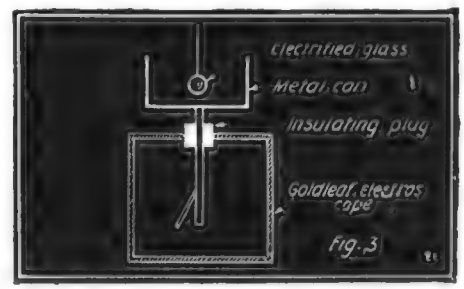
AN ALPHA PARTICLE PUNCHES THE BAG.

In an ingenious experiment it is possible to register the entrance of every alpha-particle, even tho they may enter the counting chamber at the rate of 1,000 per minute. The apparatus is indicated in the illustration. A brass sphere is supported by a metal rod inside a brass hemisphere, and the latter is connected to a set of high-tension batteries giving a potential of about 2,000 volts. The rod supporting the brass ball is connected to a very fine quartz fiber hanging between two metal plates, one of which is charged to 100 volts. Quartz is chosen because it can be made into very light fibers of great strength and elasticity. Since quartz is a non-conductor, the surface of the fiber is coated with a thin film of silver. The alpha-particles enter the vessel thru a small opening. As each one penetrates the air, it produces ions in its path, and the strong electric field of 2,000 volts causes these ions to move so swiftly that they manufacture many more ions by collision with other air molecules. Thus the electric effect due to a single alpha-particle is enormously magnified. The electric charge carried by these ions to the brass ball causes the quartz fiber to become electrified, and it is attracted towards the charged metal plate near which it is suspended. The electricity remains on the fiber just long enough to produce a "kick," and then leaks off to the earth thru a high resistance of India ink on paper. See Fig. 2. A small mirror attached to the fiber reflects a spot of light upon a moving photographic film, so that every time an alpha-particle enters the chamber the kick



Apparatus to Register Automatically a Single Alpha-Particle Emitted by Radium. Every Nick in the Line Indicates the Entrance of a Single Alpha-Particle Into the Counting Chamber. The Portion of the Trace Shown Corresponds to an Interval of Two Seconds. 1,000 Particles Entered the Vessel Per Minute, Yet Each One Is Recorded Separately.

of the quartz fiber produces a nick in the line of light registered on the film, see figure. The effect is thus just as if every alpha-particle dashed up, gave the fiber a good wollop, and then retired to make room for other athletically-inclined particles.



Simple Apparatus to Show How Radium Discharges an Electrified Insulator, Thus Proving That Radium Produces Ions in the Air.

The photographic film upon which the stunts of the particles are recorded moves at the rate of about four miles an hour, when 1,000 alpha rays enter the counting chamber per minute. When it is remembered that a microscope would be required to render visible the quantity of radium which produces only 1,000 alpha-particles per minute, and that the electrical charge carried by each particle is so small that as many of them would be required to light an ordinary incandescent lamp as there are drops of water in the modern swimming tank, the development of science that permits the registration of each alpha ray seems well-nigh unbelievable.

One must have the imagination of a poet to realize fully the wonders revealed by Science. The nearest star is so far away that an imaginary airplane traveling one mile in every second would take 800,000 years to reach it. Two celestial bodies crash together in interstellar space and burst into flames, yet the conflagration is not heralded at our earth until half a century later, altho light travels at the enormous speed of 186,000 miles per second. Terrestrial distances vanish into nothing compared to these astronomical magnitudes which must be measured in light-years. The astronomer calculates the mass of the sun, and we find our earth to be, in comparison, merely a speck of dust dancing in the sunbeam, and we, ourselves, but germs upon a mote. Turning our eyes from heaven to earth, we find that the heat and power of steam are due to the rapid vibrations of molecules which are so small that the highest vacuum we can obtain has fifty millions of them in every cubic inch. Our nearest approach to *nothing* contains fifty million particles in a cubic inch. The sudden drop from the infinite to the infinitesimal is staggering. Yet the experiments with radium show that there is a whole *solar system* in one of these molecules. The imagination refuses to function, but scientific experiments admit of no other conclusion. In order to explain the myriad facts revealed by this wonderful substance we must assume that in the very atom itself there are electrons as planets revolving in majestic orbits about a large nucleus as a sun, and recent experiments which tend to show that even an electron has potential energy, may force us to conclude that these electron-planets are composed of parts.

(*Continued on page* 115)

HOW-TO-MAKE-IT

This department will award the following monthly prizes: First Prize, $3.00; Second Prize, $2.00; Third Prize, $1.00.
The purpose of this department is to stimulate experimenters towards accomplishing new things with old apparatus or old material, and for the most useful, practical and original idea submitted to the Editors of this department, a monthly series of prizes will be awarded. For the best idea submitted a prize of $3.00 is awarded; for the second best idea a $2.00 prize, and for the third best prize of $1.00. The article need not be very elaborate, and rough sketches are sufficient. We will make the mechanical drawings. Use only one side of sheet. Make sketches on separate sheets.

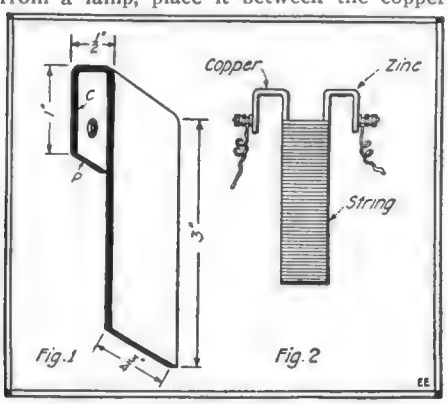
FIRST PRIZE, $3.00

A BATTERY-LESS ARMATURE TESTER.

Many experimenters desire a small device for testing rather than to carry a battery around.

To construct this tester first shape a piece of copper about 1/16 of an inch in thickness and bend at the required lengths.

The hole at (1) is drilled ⅜ of an inch from the edge (c) and 1/12 of an inch up from the end (p). After doing everything as shown in Fig. 1 make a duplicate of this out of a piece of zinc about 1/16 of an inch thick. Next obtain an old dry wick from a lamp, place it between the copper



Battery-less Armature Tester Composed of a Strip of Copper and a Strip of Zinc Bound Together, but Between Which Is Placed a Lamp Wick. The Element so Formed Can Then Be Soaked in Plain Water, Salt Water or Sal Ammoniac Solution. A Telephone Receiver Is Used to Complete the Test Circuit.

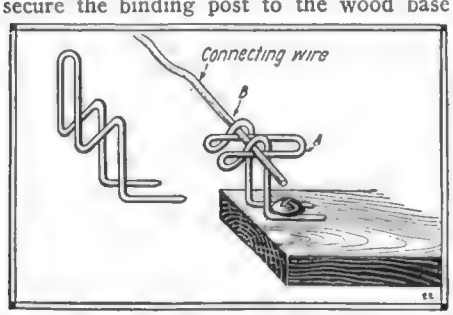
and zinc evenly. Then wind string around as shown in Fig. 2; wind tightly as if winding a tuner.

Connect a telephone receiver with it; when ready for use dampen the wick with water and very distinct sounds can be heard when testing across the segments.

Contributed by THOMAS MOORE.

HAIRPIN BINDING POST.

A good spring binding post can be made from a hairpin. Scratch the enamel off with a knife and bend the pin as shown in sketch with a pair of pliers. Next secure the binding post to the wood base



A One-Minute Binding Post Made from One of Sis's Hairpins.

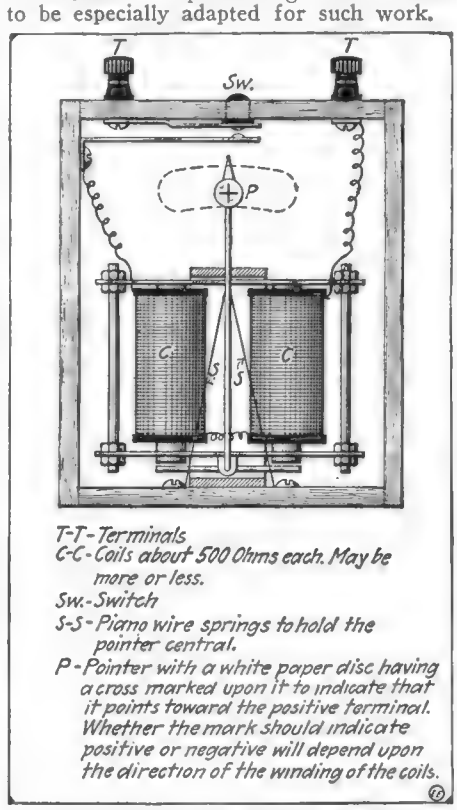
by a tack which is driven between ends of binding post as shown. The wire is inserted thru eyelets B.B. by pressing down on A. This binding post can also be made with a piece of spring brass wire.

Contributed by DAVID RASCON.

SECOND PRIZE, $2.00

MAGNETIC POLARITY INDICATOR

I enclose a sketch of a polarity indicator made from a telephone ringer which seems to be especially adapted for such work.


T
T
Sw.
P
C
C
S
S
T-T-Terminals
C-C-Coils about 500 Ohms each. May be more or less.
Sw.-Switch
S-S-Piano wire springs to hold the pointer central.
P-Pointer with a white paper disc having a cross marked upon it to indicate that it points toward the positive terminal. Whether the mark should indicate positive or negative will depend upon the direction of the winding of the coils.

A Simple and Useful Magnetic Polarity Indicator Constructed from a Polarized Telephone Bell-Ringer.

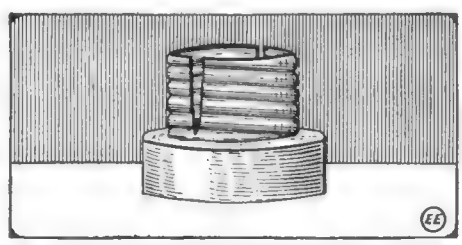
In this case I increased the throw of the needle or pointer by adjusting the armature of the ringer, I added a switch so that the tendency to make connection by touching the wire to the terminal and in time burning it off would be eliminated. The switch also acts as a safeguard against burning the coils out in case the resistance of the coils is small and the potential high. The connection or closing of the switch need be only for a moment.

Contributed by O. B. POORE.

A "QUICK TEST" LAMP SOCKET.

Remove the cover from an ordinary fixt socket and split the lamp-screw shell down opposite sides, forcing the two halves of the shell slightly apart.

Contributed by N. J. SECCOMBE.



To Test Lamp Bulbs Rapidly, Split a Socket Shell in the Manner Illustrated, so That Lamps Can Be Slipt In and Out.

THIRD PRIZE, $1.00

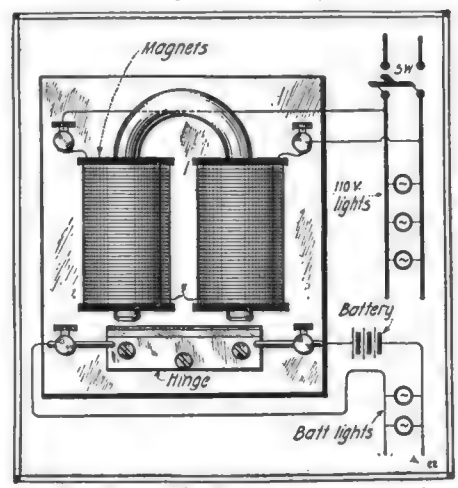
AN AUTOMATIC LIGHT SWITCH.

I herewith describe an automatic switch which will throw on battery current when the 110-volt current gives out.

The necessary parts include: A set of magnets for 110-volt circuit, two single binding posts, two double binding posts, some heavy wire, a hinge and a wooden block for a base.

The action is simple. When the 110-volt circuit is broken, the magnets release the hinge. The hinge strikes the contacts and connects the battery lights. For best results the switch should be placed vertically.

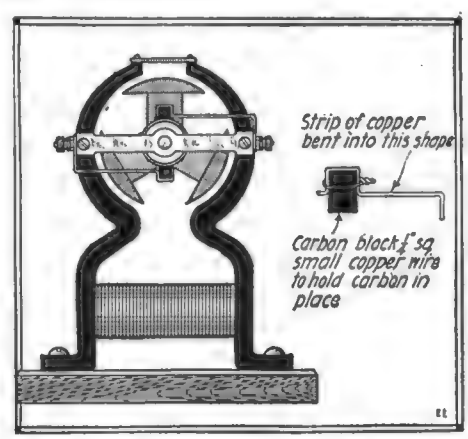
Contributed by F. J. GILLIS.



When the Main Line Voltage Falls, This Automatic Relay Closes the Battery Circuit to the Emergency Lights.

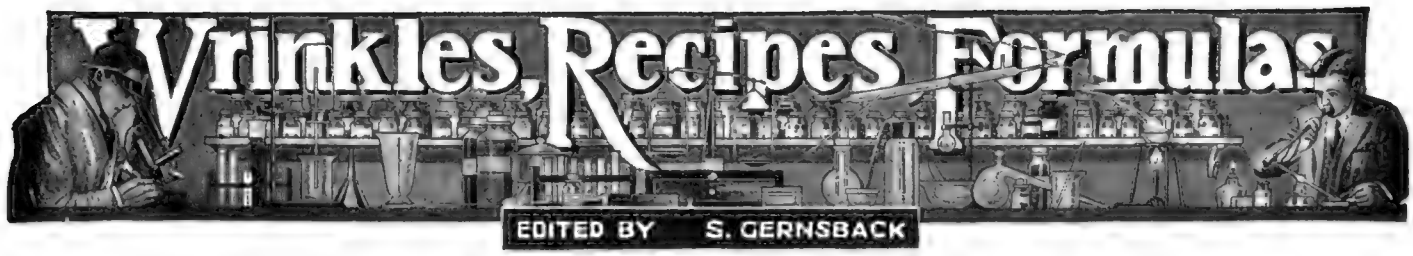
SMALL MOTOR BRUSHES.

Being a reader of THE ELECTRICAL EXPERIMENTER I give herewith a little idea for carbon brushes suitable for a battery motor, which I have tried on small motors and found that it saves the wear and tear on the commutator.



A Clever Way of Making Small Carbon or Better Grafite Brushes, for Battery Motors.

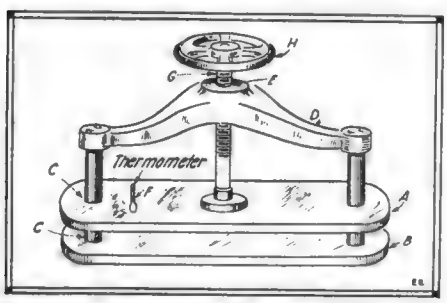
The price of the brushes will suit everyone's pocketbook, the materials used being a piece of carbon from a flashlight battery and a strip of copper.



MACHINE FOR MAKING RUBBER STAMPS.

Here is a simple, easily made machine with which any one can make their own rubber stamps. To construct the same, procure two pieces of sheet steel ¼ inch thick, 3 inches wide and 6 inches long (A.B.). Lay them together and drill holes thru at C for one-half inch bolts. Now make a strap of steel ¼ inch thick, 1 inch wide (D). Drill and lap out for half-inch rod at E. Now tap for bolt at holes in base, screwing a bolt in each. Now fix the plate A so it will slide up and down on the bolts as shown. Mount a thermometer F, also a screw G with a hand wheel H and the machine is ready to use.

To use it, obtain a sheet of stamp makers' matrix board. Set up the form with printers' type, that the stamp is to be made in. Then put this on the lower plate. Lay the matrix board on it and screw down the top plate by means of the wheel H. Now unscrew, and then lay the matrix board face up on the bottom plate; now lay a sheet of unvulcanized rubber, such as is used for packing auto tires, on the board.



By Means of This Simple Press Which Can Be Constructed by the Experimenter or Else Adapted from a Small Letter Press, It Becomes an Easy Matter to Make Your Own Rubber Stamps.

Screw down tight and set the whole machine on a stove. When the thermometer reaches 225° remove from the stove and then in five minutes the rubber is taken out and ready to fasten to the wood mount by means of glue. With this little machine anyone can make their own rubber stamps.

Contributed by A. H. WAYCHOFF.

SOAP PASTE.

Here is a soap paste that should interest every mechanic. I have used this for over a year and find it will remove paint, grease, tar, oils, etc.

To make this paste, take,

1 pound of ivory soap
1 pint water

and cut the soap in shavings. Next put in the water and get it boiling hot.

Now take one pint of light auto engine oil, and heat to the boiling point. Then stir into the soap mixture, letting it boil for about five minutes. Then add one pint boiling water. This makes a smooth white creamy paste that will remove any dirt. It it is also good for washing auto bodies, etc.

It may also be used simply by taking some on the hands, and rub well, then wipe off with a piece of clean waste or rag. No water is necessary. This leaves the hands clean, white and soft. And the best part of it all is that it only costs the small sum of 10 cents a gallon.

Contributed by A. H. WAYCHOFF.

"CEMENTS."

Cement for an Aquarium—Many persons have attempted to make an aquarium, but have failed on account of the extreme difficulty in making the tank resist the action of water for any length of time. Below is a recipe for a cement that can be relied upon; it is perfectly free from anything that injures the animals or plants; it sticks to glass, metal, wood, stone, etc., and hardens under water. A hundred different cements have been tried, but there is nothing like this. It is the same as that used in constructing the tanks of the Zoological Gardens, London, and is almost unknown in this country. One part, by measure, say a gill, of litharge; one gill of plaster of paris; one gill of dry, white sand; one-third of a gill of finely powderd resin. Sift, and keep corked until ready for use, when it is to be made into a putty by mixing in boiled linseed oil with a little patent dryer added. Never use it after it has been mixed with the oil for over fifteen hours. This cement can be used for a salt water aquarium.

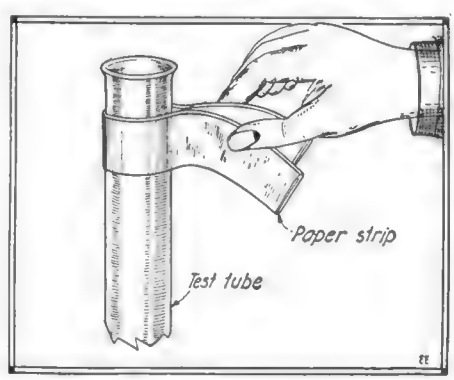
Cement for Attaching Metal to Glass—Take two ounces of a thick solution of glue, and mix with one ounce of linseed-oil varnish, and half an ounce of pure turpentine; these are to be boiled together in a closed vessel. The two bodies should be clamped and held together for two days after they are united.

Cement for Mending Broken China—Stir plaster of paris into a thick solution of gum arabic till it becomes a viscous paste. Apply it with a brush to the fractured edges and draw the parts closely together.

Contributed by RUSSELL M. REED.

TEST TUBE HOLDER.

A substitute for the usual wire holder used for handling test tubes can be made in a few seconds from a square of heavy wrapping paper folded to a strip one inch wide and eight inches long. The paper strip is wrapt around the tube, the ends being held between the fingers as shown.



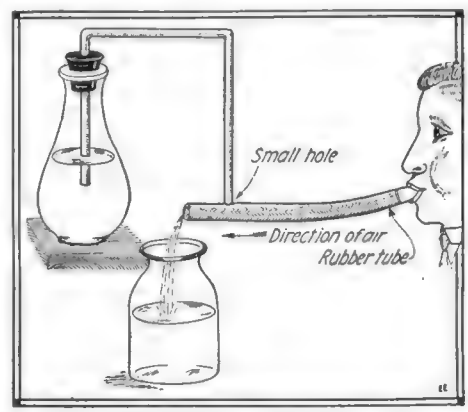
The Accompanying Illustration Shows a Simple Way to Hold Test Tubes, Especially When They Are Heated, by Means of a Paper Strip Doubled and Then Slipt Over the Test Tube and Clampt With the Fingers.

In this manner the tube can be held tightly without danger of crushing the tube or burning the fingers. This little stunt is used in one of the large commercial laboratories.

Contributed by THOS. W. BENSON.

A SIMPLE WAY TO START A SYPHON.

Contrary to the ordinary way of filling a siphon, by suction, all danger of getting any of the liquid in one's mouth may be avoided by using the simple method described below. A common piece of rubber tubing is the only apparatus required. A small hole is made in this to tightly fit the tube of the siphon as shown in sketch.



Here Is a Simple Way in Which to Start a Siphon by Blowing Thru an Auxiliary Piece of Rubber or Glass Tubing. The Air Blowing Thru This Tube Causes a Suction to Be Set Up in the Down-Coming Pipe, and This Causes the Liquid to Be Sucked Upward Into the Pipe from the Upper Jar. Once Started the Siphon Works Itself.

When air is blown thru this tube at A it causes a partial vacuum in the siphon, which in turn causes the liquid to rise in the siphon. The rubber tube may be left on or removed as desired. The liquid will then start flowing. The advantage of this method is in the absolute avoidance of any liquid entering the mouth. The rubber tube can be of any length, and the hole in it should be made to fit the siphon air-tight.

Contributed by EDMUND SMITH.

TO CAST FIGURES IN IMITATION OF IVORY.

Make finely ground isinglass (mica) and egg shells into a paste with strong alcohol. This mixture should be carefully warmed and then cast into your mold, which should be well oiled over.

Leave the figure in the mould until dry, and you will find upon taking it out that it bears a very strong resemblance to ivory.

If desired, the warm paste may be tinted with any color you may wish.

Contributed by
WALTER CHAS. MICHEL.

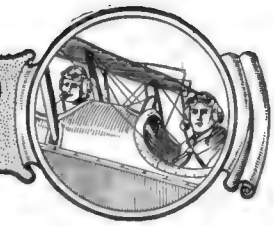
TO MAKE FUSIBLE SPOONS.

Melt about four ounces of bismuth in a crucible, and, when fused, throw in about 2½ ounces of lead, and 1½ ounces of tin. These metals will combine and form an alloy, which melts at a very low degree of heat.

If some of it is formed into teaspoons (which may easily be done by making a mold in clay from another spoon), the spoons thus made will cause much amusement; for if one be placed in hot tea it will melt, or if it does not melt it will bend, considerably surprising the person using it.

Contributed by
FRANK. R. NICKERSON.

RADIO DEPARTMENT



The New Radio Corporation

By C. D. WAGONER

of the General Electric Company.

CONNECTING the nations of the world by wireless thru mammoth radio stations, equipt to send messages at the rate of 100 words a minute is the plan of the newly organized *Radio Corporation of America.* These stations will be similar to the one at New Brunswick, N. J., which accomplisht some wonderful feats during the last six months of the war. The radio service establisht by this station proved to be reliable practically every day of the year and every hour in the day. It was thru this station that President Wilson kept in close communication with Washington while at sea on the transport *"George Washington,"* it was thru this station that instructions were sent to the great armies overseas and it was also via this station that President Wilson sent his famous message demanding the abdication of the Kaiser.

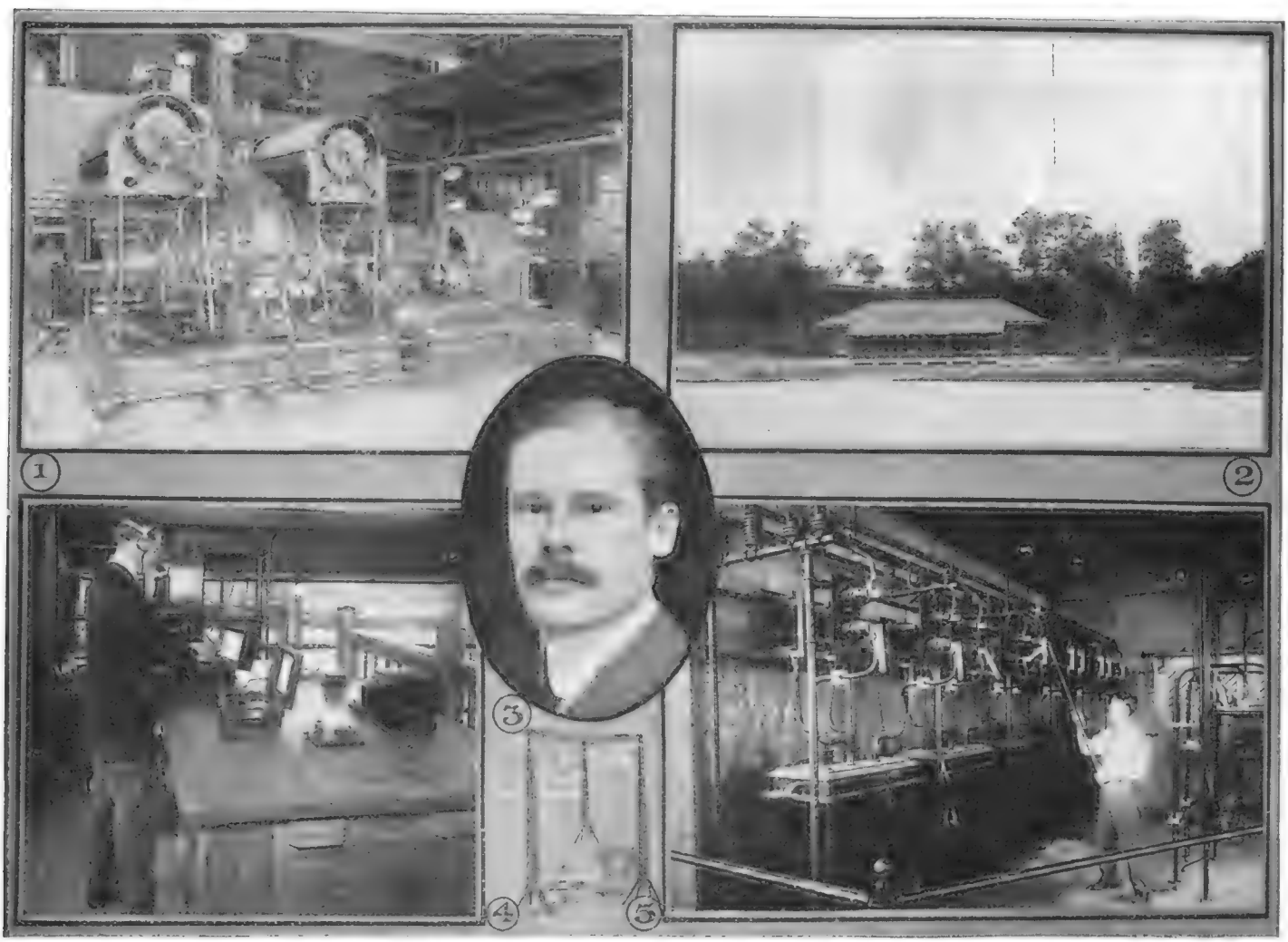
Thus the war, bringing about this remarkable achievement in wireless, demonstrated the great possibilities of supplementing the now overcrowded cables and bringing America to the front in the world's commerce.

The Alexanderson alternator is known for its clean cut and pure wave or tone, which can be so easily distinguisht that the messages do not get mixed up with each other even if they are of nearly the same wave lengths. Thus, five such alternators may be operated simultaneously transmitting five separate messages, where older types of apparatus could send only one.

Up until this time when we have thought of wireless we have always thought of Marconi, because he has been the principal factor in its development. Now a new name enters the field. It is that of Ernst F. W. Alexanderson, consulting engineer for the General Electric Company and considered one of the foremost radio experts of the world. He came into the limelight with the invention of his high frequency alternator, the machine which made possible the accomplishments of the New Brunswick Station.

But this is not all that Mr. Alexanderson has done for the wireless art. His *magnetic amplifier* and *barrage receiver* have also proven big assets in trans-oceanic radio. The former, a device attached to the alternator, magnifies a telephone current into a trans-oceanic radio message, and the latter in an instrument whereby the operator may turn a deaf ear to all signals or noises other than those intended for him. This is important, as brought out in the tests made during the war. The Germans endeavored to destroy communication between America and France by sending out equal wireless wave lengths and under ordinary conditions they would have been successful, but with this barrage receiver the operator was able to pick out the message he wanted and bar all others. This device also makes it possible to receive messages from several sta-

(*Continued on page* 110)

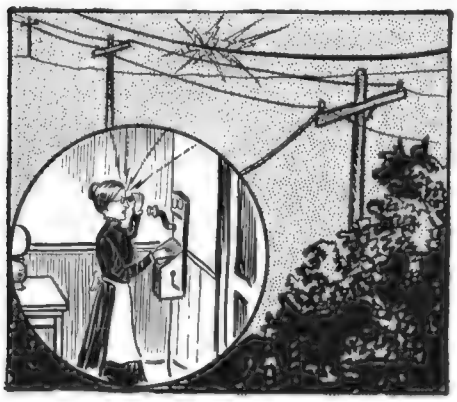


1—Alexanderson High Frequency Alternator, Which Has Made Possible Sending Wireless Messages 3,000 Miles at a Speed of 100 Words Per Minute. 2—Operating House at the Trans-Atlantic Receiving Station for the Radio Corporation of America, Belmar, New Jersey. 3—E. F. W. Alexanderson, Inventor of New High Frequency Alternator and Chief Engineer of Radio Corporation of America. 4—The Operating Table at the Trans-Atlantic Transmitting Station at New Brunswick, New Jersey. 5—A Bank of Condensers at the New Brunswick, New Jersey, Station, of the Radio Corporation of America.

A War-Time Radio Detective

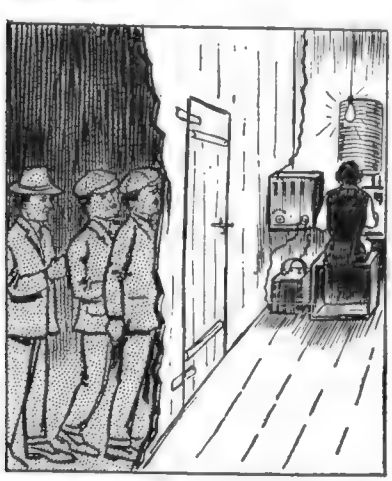
By PIERRE H. BOUCHERON

I MUST start off with an apology. War stories are admittedly passé, so if I mention the words "great war", "German spy", "submarine", "spy radio stations", etc., a little too often please have patience with me as in some cases it will have to be done, even at the cost of the reader's displeasure.



Among Several Thousand Choice Stories Sent in to Be Investigated by Patriotic Citizens During the War Was That Vouched for by a Lady, Who Swore That She Heard Secret Dots and Dashes of the Telegraphic Code on Her Telephone Every Day, at a Certain Time. This Was Investigated and Found to Be Due to a High Tension Line Brushing Against the Telephone Wires.

During the recent "scrap" it was my good fortune (or shall we call it misfortune) to be connected with a no less awe-inspiring outfit than the "Intelligence Department" of the Radio Censorship Bureau. It was the duty of men attached to this department to investigate reports of illegal radio activities occurring in neighboring districts. The sources of information came from all manner of ways, such as the secret service, allied bureaus of information, various governmental bureaus, the police, home defense leagues, amateur "deteckatives," and sometimes over-zealous citizens. They forwarded the reports by telegraph, cable, special delivery mail and "fleet-footed" messengers. In one case, a patriotic youth actually ran a marathon (27 miles, isn't it?) in order to inform us that Mr. Heinberger of Dingville, L. I., had been seen using a pocket flashlight for "signaling" purposes at 3.00 o'clock in the morning.



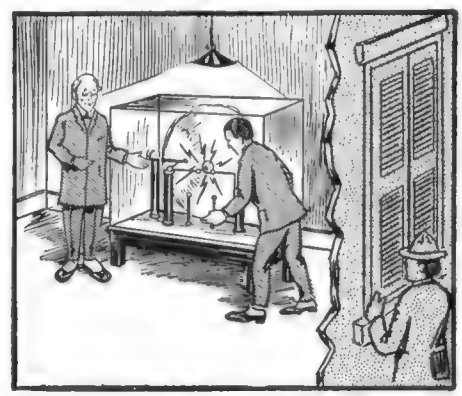
Finally, After Chasing Hundreds of False as Well as Worthy Spy Cases, a 100 Per Cent Radio Spy Was Located and caught "Red Handed" by the Author and the Secret Service Operatives. The Camouflaged Antenna Used by This Spy was Truly a Work of Art.

No. 1. A Few Accounts Describing Some Unusual Experiences Connected With War-Time Radio

Many of these reports were totally unfounded and in many instances were even ridiculous in their childish character, demonstrating total ignorance of "radio telegraphy" matters. Well-meaning but misguided persons (males and females, if you please) would note a peculiarly twisted clothes line in a back yard, or a telephone wire running between two houses, or a guide wire attached to a pole or tree and would immediately decide that the locality was the rendezvous of "spies" in direct communication with the *Wilhelmstrasse,* in Berlin.

Strange to say these reports had to be investigated whether they appeared ridiculous or not, and it was often my lot to have as many as four or five of these reports to work upon during a single day. Of course there were many of them which on the surface looked fairly reliable and seemed to be really suspicious and worthy of the skill of some of our best men. I will say, however, conservatively, that not more than 5 per cent of the investigations resulted in a discovery of some plan definitely designed to secure information by means of *radio* and thereby break the existing laws concerning complete dismantling and inoperation of all unofficial radio stations in the United States.

I will, therefore, cite a few of the many cases which at first gave great promise, but alas, turned out to be complete fiascoes. This may give the average reader an idea of the amount of time and expense which the government was obliged to put forth in order to thoroly investigate the reports of well-intentioned, tho too often misinformed patriots.



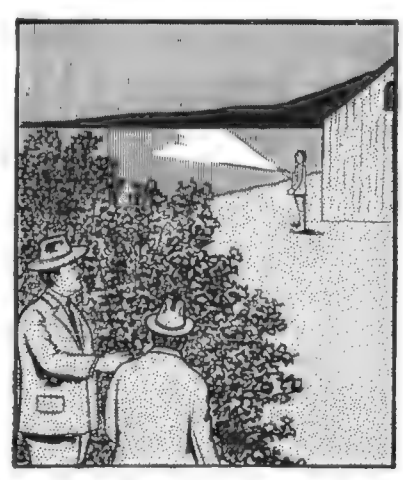
The "Static Manufacturing Plant" Was a Wild Tale, Which We Are Not Going to Disclose Here. A "Boy Scout," Passing by a Doctor's Office Near a Naval Radio Station, Heard the Static Spark Crashes and Reported the Matter. The Outcome of This Mystery Is Entertainingly Told by the Author.

THE "STATIC MANUFACTURING" PLANT.

In the spring of 1918 there came to our notice a report to the effect that a large static machine had been installed in the immediate vicinity of the Brooklyn Navy Yard. The machine, it was said, had been designed for the express purpose of sending out "static" on a broad wave and thereby seriously interfere with the reception of important naval dispatches at the Brooklyn Navy Yard radio station. That is to say, the apparatus was capable of simulating *strays* or atmospheric disturbances known in the parlance of radio men as *static.* Coincident with this, it may be well to say that during this time the local naval radio station was encountering difficulty with regular and very real static, so that a report of this nature coming at this period was worthy of investigation; and particularly so, for it came from Secret Service operatives.

This happened to be my first case so I was more than anxious to make good. I therefore sallied forth, armed to the teeth,

(*Continued on page* 102.)



Another Wild Tale Which Looked 100 Percent "Gilt Edge" Was That of a Man Who Was Seen at Certain Times Using a Pocket Flashlight at Night. Investigation Proved This to Be a False Alarm, as the German Using the Flashlight Was Only a "Peaceable" Farmer Going About His Chores.

FOREWORD

No, regular subscriber, the "radio detective" is not a new system of dictagraph, nor is it a twenty-fifth century mechanical device having the power of tracking down criminals by means of distant radio control. The radio detective is, or rather was, (for he has temporarily ceased activities since the fall of October 1918) *a very ordinary human being just like yourself, possest, however, with the knowledge of being able to distinguish a radio antenna from a clothes line, as well as the unusual ability of being able to "nose out" an underground antenna within a radius of one mile. This individual was formerly a regularly enlisted radio operator of the U. S. Navy or Army, who, during the war, pursued his unusual calling in various sections of the United States and particularly in districts close to the Atlantic and Pacific coasts. He operated alone but sometimes was accompanied by an assistant. His equipment consisted of a sma'l hand-bag which contained a complete portable radio receiving set of a rather original design, an automatic revolver, and a raincoat! In some instances the portable set included a loop or radio compass so that when the trail was especially strong, "bearings" of unknown transmitters could be secured. But this is getting ahead of the story so we will let the author tell it in his own words.*

New York Girl's Radio Set

By ABBY P. MORRISON

I GIVE herewith a detailed description of my radio set, which has been in commission since the War ban was lifted, and it has given me very satisfactory service. It is purely home-made except for the condensers, one of the couplers, audion box and batteries.

The three-foot-square "loop aerial" frame, wound with twenty-two turns of rather heavy wire, is not shown in the picture. It was made by myself. In addition the loop 3'x 1½', noted in the background, was wound on a trunk tray with twenty turns of fine double cotton covered wire. With the latter loop and an audion detector I am able to receive local, Navy Yard and ship signals; with the former loop considerably larger I receive 600-meter messages and when using all twenty-two turns receive those of 952-meter wave length. This wave length I have presumed to be accurate without resorting to wave-meter tests, inasmuch as the messages come from the Navy Yard and from ships a day or two out at sea.

These nearby messages I have detected with the three-foot loop and on a crystal detector very clearly. I have not had time to experiment much with either this loop or a four-foot home-made loop just added. However, with an outdoor aerial of four wires, seven-strand copper, spaced each two feet apart and spanning about eighty-six feet in length with a lead of forty feet, I have received signals up and down the coast and out to sea for a good distance. These signals, both dampt and undampt, included, as well as ship and coast wavelengths, Arlington and the higher waves.

Miss Abby P. Morrison and Her Elaborate Experimental Wireless Station. Miss Morrison Receives on an Indoor Loop Aerial Which She Built Herself.

The set beside the aerial and loops contains two home-made coils of No. 28 wire wound on cardboard tubes three inches in diameter, being respectively 1¼ feet and 1½ feet in length, which I can use either as inductances or as a coupler. I have also a large old coupler, the secondary of which pulls out on a set of wheels. This works very smoothly and efficiently.

There are four other home-made coils, each wound tightly, the winding separated by layers of waxed paper, to distribute the capacity, and mounted between two pieces of cardboard four inches square. The Audion is mounted on a panel, the box of which contains a "B" battery of ten square dry cells, aggregating forty volts. On the front of the box are two switches, one of three taps for switching off the "A" battery from the filament and, in case of a bulb with two filaments, enables the change from one filament to the other. The other switch has five taps for regulating the amount of current from the "B" battery, sections of which are attached to each tap. The Audion in use at present is an old-fashioned tubular one which necessitates the box to be placed on the edge of the table to enable the end of the bulb to rest comfortably below the table level. On the right side of the box is a filament battery rheostat and binding posts for the "A" battery. On the left side are binding posts for the telephone and tuning circuit. I have had to rearrange the wiring inside the box on account of my desire to try out different circuits, also occasionally substituting a new battery for the old one. A small "grid condenser" is contained within the box, and I have found no need for a grid leak, altho I always have one at hand in case of necessity.

I have used nearly all of the ordinary audion circuits and also those employing a tickler. Eight variable condensers and the 'phones, together with odds and ends, complete the station.

A friend of mine, recently returned from France, has brought me a complete set, picked up practically from the battlefield, consisting of a German and French combination, five-step amplifier, one step of which can also be used as detector, condensers, coils, batteries, etc., for receiving. There is also in this set complete sending apparatus consisting of a spark coil, a rotary spark gap, batteries, step-up and oscillation transformers, condensers, etc. I also have a ¼ kilowatt motor-generator.

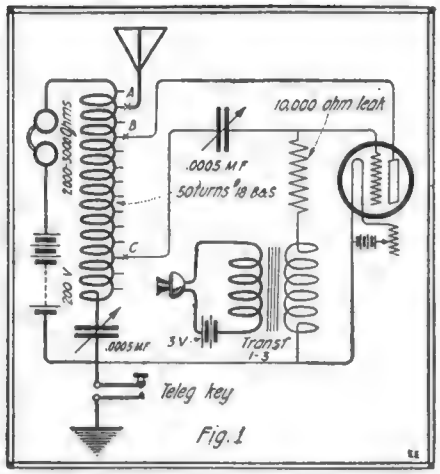
Plan For World-Wireless

A scheme now under consideration in France for embracing the whole globe with wireless stations erected wholly on French territory is described in a recent issue of *Le Génie Civil*, by Mr. Boutillon, head of the French Government wireless department. As the result of a mission to America in 1917 to study the wireless systems of the New World, the author has concluded that to assure continuity of communication at great distances powers much higher than those now usual are needed. The following is an abstract of the Boutillon article:

"All the great stations in existence (with ranges from 3,000 to 5,000 miles), with the exception of Nauen, employ powers between 200 and 400 kilowatts, and possess antennae ranging in height between 500 and 650 feet. The energy radiated from them is overabundant in the periods most favorable for transmission, but is insufficient when, as often in summer, to unfavorable conditions of transmission are added strong atmospheric disturbances. Communication then may remain impossible often for many hours together. To overcome this inconvenience, the author holds it needful to raise the power to at least 1,500 kilowatts and adopt antenna of at least 1,500 feet in height. As regards the world-embracing network, the author proposes a continuous line of stations of about 3,700 miles' range, which, starting on the west, will comprise the stations at Tahiti, New Caledonia, Indo-China, Djibuti, and France, where splitting into two arms it will terminate at the Senegal and Martinique stations, respectively. The center of the network is naturally placed in France, and comprises a station of medium power able to communicate with North Africa and three stations of great power to communicate respectively with (1) the United States; (2) Martinique and Brazil; (3) West Africa, and with Djibuti. In West Africa, at Djibuti, and in Indo-China there will be double stations (one of great power to communicate at great distances, and one of medium power for local uses). In detail the network will comprise (1) a quadruple station in France (three stations of great power and one of medium power); (2) three double stations; West Africa, Djibuti, and Indo-China (one large station and one medium); (3) three stations of great power; Martinique, New Caledonia, and Tahiti; (4) six stations of medium power: Morocco-Algeria, Tunisia, Kongo, Madagascar, and French India. As to the organization of the multiple stations the author proposes to place transmission centers at considerable distances one from the other. For instance, in France the four transmission centers will be situated at Arles, Nêmes, Bordeaux, and Basse Loire. Reception posts may be placed near those of transmission, and at such a distance as to permit the service in duplex or (and this solution the author seems to prefer) may be united in a single center of reception near Paris, which they will communicate by wire with the four sending posts."

A One Tube Radio-Telegraph and Radio-Phone Transmitter

By PIERRE H. BOUCHERON

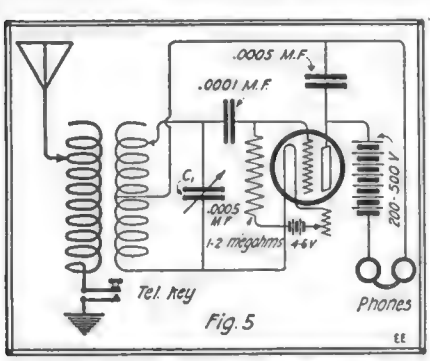


Complete Wireless Telephone Hook-Up, Sending and Receiving, Using but One Audion.

AMATEURS, do you realize that a great deal of interesting experimenting is at the present day done by many amateurs all over the country employing undampt wave transmission? For the most part this is being accomplisht by the use of one or more vacuum tubes on oscillating circuits well below two hundred meters. This is possibly one of the reasons why you do not hear them. Another reason is that it is continuous wave and not readily intercepted when ordinary dampt wave receivers are employed.

Some of you who have the necessary equipment, simply hook up a short wave regenerative circuit, or any other form of oscillating vacuum tube connection, then tune down from two hundred to one hundred meters, and behold, you will hear a regular medley of *amateur undampt signals.* This of course applies to thickly populated districts notorious for their generous scattering of amateur aerials; such as, for instance, New York, Philadelphia, Boston, Baltimore, Chicago, New Orleans, San Francisco. Los Angeles and their respective suburban districts.

A Marconi vacuum tube of the receiving type, or any other receiving tube of dependable manufacture, when used in a radio phone circuit having the proper constants, will, under good operating conditions be sufficient to carry on conversation within a distance of five miles altho a friend of the writer's has frequently covered twice this distance. Therefore, if five miles can be covered by the use of one tube it may be estimated that a considerable additional distance could be covered by employing a series of tubes. However, owing to the considerable initial expense of the tubes as well as the up-keep of such an arrangement, Radio-telephony under conditions of this kind is not always practicable nor possible for the average experimenter's pocketbook. For instance, the much talked of government test at Washington some years ago in which three hundred and ten tubes were employed, and where a space of approximately 5,400 miles was effectively bridged by the human voice, cost for the operation of the vacuum tubes alone was about $10,000 per hour. We will therefore confine our immediate attention to a circuit employing one tube, the total cost of which should not greatly exceed $20. As a matter of fact the actual cost will be less, for there are few amateurs indeed who have not at least one vacuum tube at their disposal. Providing we have the tube, the biggest item is therefore the plate voltage battery which must have a potential *of at least two hundred volts.*



Undampt Radio-Telegraph Transmitter Using a Single Audion for Generating the Oscillations.

In May "Radio Amateur News"

A Practical Radiophone for the Amateur.
By Herbert W. Harmon.

Found via Radio
By Leroy Archer

A Compact Vacuum Tube Control Panel
By J. Stanley Brown.

Pioneer Days in Wireless Telephony.
By Austin C. Lescarboura.

Timely Information on Aerials.
By Pierre H. Boucheron.

French Applications of Vacuum Tubes
By our French Correspondent.

A Synchronized Commutator Set for Spark Coils.
By Nat Sauberman

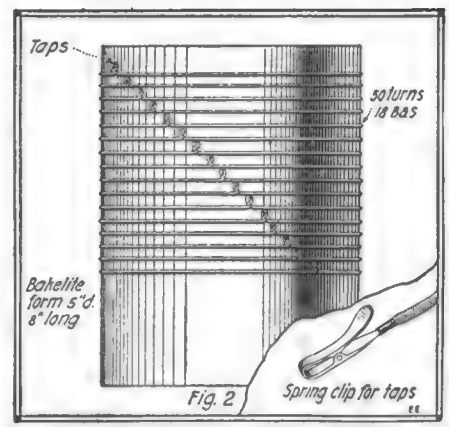
A Closed Core Magnetic Rectifier.
By J. Stanley Brown

NECESSARY INSTRUMENTS.

In Fig. 1 we have a simple and yet effective circuit which may be employed for either radio-phone or for continuous wave radio telegraphy. It will be noted that *conductive* coupling between the antenna and the tube circuit is employed rather than *inductive,* for it has been found to give better results in radiophone circuits of the kind. The reason for this is that a greater amount of energy is transferred to the antenna with a single coil of this type than would be the case with a loose-coupler arrangement, and the resulting wave is sharp enough to cause little or no interference.

Briefly the instruments necessary to carry on experimenting in this direction are as follows:

1. A vacuum tube with suitable filament battery and rheostat.
2. A variable inductance.
3. A pair of 2,000 or 3,000 ohm receivers.
4. A plate battery of 200 or more volts of the small flash light type.
5. Two .0005 mfd. variable condensers.
6. A 10,000 ohms grid leak.

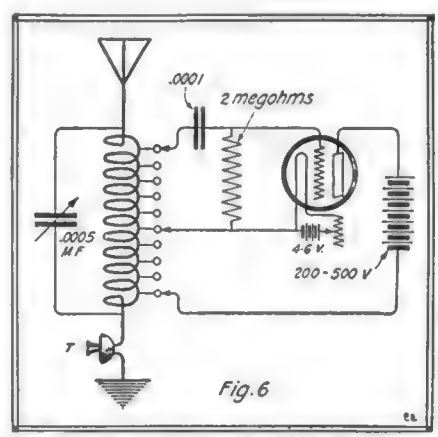


Detail of Inductance Coil Used in Wireless Telephone Transmitter of the Single Bulb Type.

7. An ordinary telephone repeater with a one to three ratio between primary and secondary.
8. An ordinary telephone transmitter.
9. Two large dry cells.
11. An ordinary telegraph key.
11. Suitable flexible wire connectors.

It will be noted that the greater part of the above instruments are usually part of the amateur's equipment except possibly the telephone repeater coil. This, as well as the telephone transmitter, may be purchased at most any experimenter's supply house at about $1.00 a piece. The preparation and construction details of the instruments necessary to complete the experiment may be briefly described as follows: The variable inductance is made by first securing a Bakelite—dilecto or fiber tube, five inches in diameter and eight inches long. If this form of tubing is not procurable, cardboard may be used instead, providing it is well coated with a good insulating preparation such as molten paraffine. Upon this form should be wound fifty turns of number eighteen B & S cotton or silk covered wire, or even ordinary bell wire may be used. It is advisable that these fifty turns be tapt. This may be done in the following manner: after having wound a complete turn a small loop of the wire is scraped of its insulation then twisted, and this small twisted loop is left projecting from the coil. After this the second turn is wound and upon arriving at the first tap, or twisted loop, the second

(*Continued on page* 107)

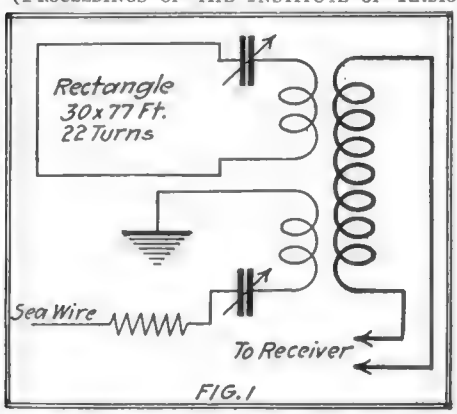


Simple Wireless Telephone Circuit Having Microphone in the Ground Circuit—a Standard Form of Connection.

Long Waves and "Strays" on Rogers Antennae

By LIEUT. COM. A. HOYT TAYLOR, U. S. N. R. F.

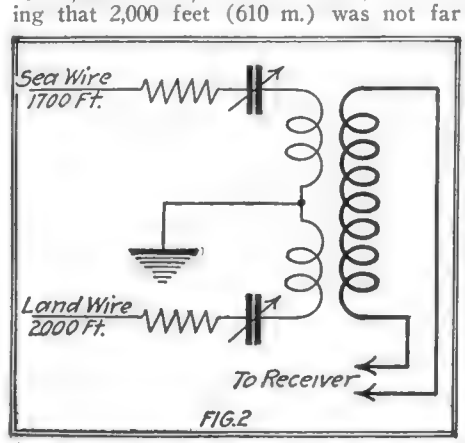
MANY of the properties of ground wires with respect to long wave reception have been touched upon in a previous paper which dealt mainly with short wave work (PROCEEDINGS OF THE INSTITUTE OF RADIO ENGINEERS, volume 7, number 4, 1919). "The purpose of this paper is to take up some of the special problems of long wave reception with ground wires, with special reference to the work done by the writer on the elimination of strays," Commander Taylor continues in the December, 1919 issue of the Institute of Radio Engineers' Proceedings.



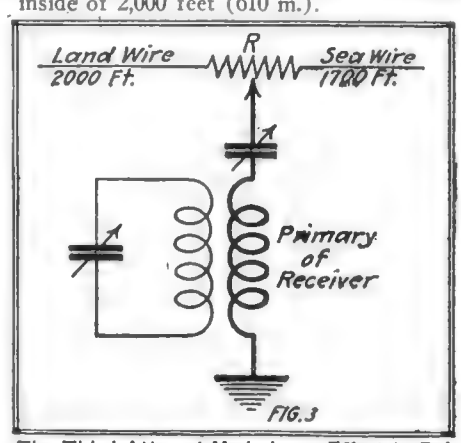
It Having Been Determined That the "Sea" Wires Had Twice as Good a Ratio for Signals and Strays as Rectangles. It Seemed Likely That One Ought to Be Able to Balance the Strays from a Rectangle, Those from the "Sea" Wires and Strays Having Some Signal Strength Left. The Differential Transformer Used in this Experiment Is Here Shown, There Being Two Primary Coils, One for the Loop and One for the "Sea" Wire Circuit.

OPTIMUM WIRE LENGTH FOR LONG WAVES.

Number 12 rubber covered wire was used for all of the earlier experiments on optimum wire length because it was found to hold its insulation for several weeks and was cheap and easy to handle. It is not recommended for permanent installations. It has already been shown that for 600 meters the optimum length for this wire was 125 feet (38.1 meters) each way, and that up to 1,125 meters this length seemed to be proportional to the wave length. It was therefore expected that a similar relation would hold for waves between 4,000 and 15,000 meters. For 12,000 meters the length was therefore expected to be 2,500 feet (763 meters). Since there was comparatively little arc work being done by stations south of Great Lakes, and since there were no arc stations north of Great Lakes, it was necessary in the work done there, to attempt optimum length experiments on stations either east or west of Great Lakes. At the laboratory on the bluff, it was not possible to lay wires in trenches for so great a distance, while at the station on the beach, it was only possible to lay a wire in one direction, using it against a ground. An attempt was made in two ways to determine whether or not optimum length existed for these long waves. First the signals from Lyons, France, on 15,000 meters were observed on a wire 3,000 feet (915 m.) long, running straight east into the lake, the outer end of the wire being sixty feet (18.3 m.) under water. This wire was gradually pulled in and observations taken. It was a laborious and difficult matter to obtain satisfactory observations in this way, but those that were taken indicated that 2,650 feet (808 m.) gave the best signal for Lyons. The signals were too weak to get, with the amplification at that time available, any adequate measure which would indicate whether the ratio of signal to stray was better at this length than at others. About this time Doctor L. W. Austin reported that, as far as he could determine from the experiments made in the slightly brackish water of the Potomac at Anacostia, District of Columbia, there was no optimum wire length for long waves and that no proportionate increase in signal was observed after 2,000 feet (610 m.). In the Great Lakes experiments, all signals were compared with those received on a standard wire, 2,000 feet (610 m.) in length. In order to avoid the laborious process of hauling in the long wire, which occupied considerable time, the problem was attacked at Great Lakes on a different basis. Two wires, separated 50 or 60 feet (15 or 18 m.), running in the same direction were compared. They were both fixt in length, one being 2,000 feet (610 m.) and the other 1,750 feet (534 m.) long. For various wave lengths between 5,000 and 14,000 meters, the ratio of signals on the 2,000 foot (610 m.) wire to signals on the 1,750 foot (534 m.) wire was determined. These observations were insufficient in number to be at all conclusive, but the best ratio was obtained at 12,600 meters, Nauen's wave, indicating that 2,000 feet (610 m.) was not far from the optimum length for this wave. It is, of course, possible that the relation between optimum wire length and wave length is not exactly linear, and it is deemed that the data herein reported is not entirely satisfactory. The experiments on optimum length were continued later at the U. S. Naval Radio Station, Belmar, New Jersey, which was then the principal station and control center of the trans-Atlantic system and where the writer was stationed as trans-Atlantic Communication Officer. The Belmar experiments on wires laid in the inlet (salt water) in front of the radio station, showed that up to the length of 1,500 feet (458 m.) signals from Nauen on 12,600 meters continued to increase. It was impossible to obtain a greater distance than 1,500 feet (458 m.) without deviating too far from the proper direction. During the month of January, ice formed on the inlet and a piece of "packard cable," number 14 high tension, was laid on the surface of the ice for the purpose of determining the optimum length of Nauen's short wave, 6,300 meters. The signal strength rose rather rapidly until a thousand feet (305 m.) were used, after which it rose very slowly so that it was difficult to determine exactly where the optimum length lay. It was estimated to be 1,600 feet (488 m.). Similar experiments with a wire on the ice, using Lyons' spark wave of 5,300 meters, indicated an optimum length of 1,200 feet (366 m.) and showed also that the rise of signal strength was very gradual and that there was no practical advantage in using over 800 feet (344 m.) of wire for 5,000 meters and not over 1,000 feet (305 m.) for 6,000 meters. About this same time, January, 1918, *lead-covered cable* on the surface of the ground was tested at Belmar. The sheath of the cable was grounded at a number of points, special care being taken to get a good ground at the receiving end. The core of the cable contained two number 18 copper wires, which were connected to the receiving set and used against a ground connection. The behavior of lead-covered cable showed at once that the most suitable length for long waves was decidedly different from that proper for ground wires or submerged wires. For instance, while 2,000 feet (610 m.) of underground wire was found very suitable for waves of 10,000 meters and upwards, it was found that a lead-covered cable 3,000 feet (915 m.) in length showed up best on wave lengths between 5,000 and 6,000 meters. A lead-covered cable 7,000 feet (2,135 m.) in length was then opened at a series of points 500 feet (153 m.) apart and observations were taken on Nauen's 6,300 meter wave, comparison being made in each case with the signals obtained on a fixt 2,000-foot (610 m.) ground wire. A curve was plotted from this data which showed a maximum at 3,000 feet (915 m.); the curve was, however, very flat. A little later experiments were undertaken with a ground wire buried seven feet (2.1 m.) deep, a number of pits having been dug for the installation of disconnecting switches. Observations were taken on signals on 9,500 meters from Stavanger, Norway, and on Nauen's 6,300 meter wave. The total length of ground wire available was 2,000 feet (610 m.). The observations were inconclusive, the Stavanger signals at 9,500 meters indicating a maximum when the full length of the wire was used, whereas measurements on Nauen indicated a linear rise proportionate to the length of the wire, that is to say, the Nauen observations indicated no optimum length inside of 2,000 feet (610 m.).



Another Attempt Made at Balancing Out the Signals and Strays Was Made, as Here Shown, by Placing a "Land" Wire Against a "Sea" Wire, but with Indifferent Results.



The Third Attempt Made in an Effort to Balance the Signals and Strays Is Here Shown. A Small Potentiometer, R, Permits the "Land" Wire To Be Balanced Against the "Sea" Wire. This Arrangement Did not Give the Results That Had Been Expected.

RATIO OF SIGNALS TO STRAYS.

In order for the ground wire system to be of practical value it must be able to show advantage in readability of signals not only over an ordinary aerial but over a properly designed receiving frame or closed loop, since the latter is more compact and easier of installation. The elimination of *actual static* is, of course, fairly complete on the ground wires, but the relative advantage of ground wires over rectangles, as far as the elimination of *all* strays was concerned, had to be made the subject of exhaustive tests. Early in January, 1918, the writer requested Lieut. A. Crossley at Great Lakes, to construct a rectangle 11 feet (3.36 m.) square, wound with 80 turns of number 13 double cotton-covered wire spaced 0.5 inch (1.27 cm.) apart. This rectangle was compared for a considerable period of time with the 1,200 foot (366 m.) "packard cable" at the Great Lakes laboratory station on the bluff, the cable being buried four feet (1.22 m.) under the surface of the earth. The ground wires gave signals averaging three times as strong as those on the rectangle. The ground at that time was partly frozen.

The average readability of signals at Great Lakes was 62.6 per cent better on the ground wire than on the rectangle. About the time the frost penetrated well into the ground at Great Lakes, it had been noted that the strays became distinctly worse. The same thing was noticed on the sea wires at Belmar when the shallow inlet froze up so that the wires were partly covered with a three-inch sheet of ice. In order to get further evidence, wires were laid at Belmar on top of the ice and directly over the sea wires and the ratios of signals to strays on many trans-Atlantic stations were obtained in comparison with the signals on the sea wires frozen in the ice. The readability of signals, defining readability as the ratio of signals to strays, was twice as good on the sea wires under the ice, altho not as good as on the same wires without any ice over them. In the meantime hundreds of observations had been accumulated at Belmar comparing the ratio of signals to strays received on rectangles 77 feet (23.5 m.) long by 30 feet (9.2 m.) high, with 12 turns of number 10 copper wire spaced 6 inches (15.2 cm.) apart, with those obtained on 1,200, 1,400, and 1,700-foot (366, 427, and 519 m.) sea wires and with those obtained on a 2,000-foot (610 m.) land wire buried 2 feet (61 cm.) deep. Many observations were also made on a 2,000-foot (610 m.) land wire buried 7 feet (2.14 m.) deep. This latter wire gave louder signals than the one buried 2 feet (61 cm.), but the same ratio of signals to strays. The general average showed that the signals obtained on rectagles and sea wires were of approximately the same intensity, but that the readability of the signals received on the sea wires was twice that received on the rectangles. On the other hand, the ground wires, altho giving signals four to five times as strong as the rectangle, showed no advantage whatever in readability.

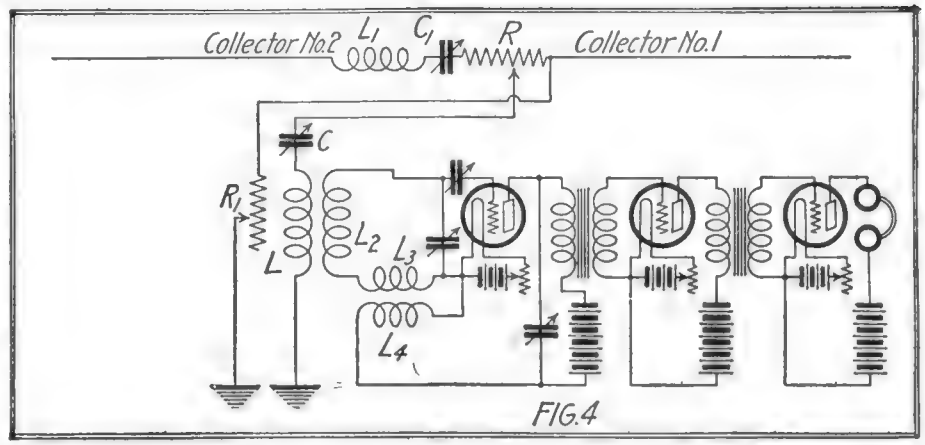


FIG.4

This Illustrates the Circuits Used in the Final Arrangement for the Balancing of the "Land" Wire Against the "Sea" Wire, Where a Phase-Adjusting Device, L_1C_1, Is Put in Series with Either "Land" or "Sea" Wire. The Signals Were Amplified by Several Audions in the Manner Indicated.

THE ELIMINATION OF STRAYS FROM LAND AND SEA WIRES.

It was finally decided that the only way to do anything towards the further suppression of strays over and above that already obtained by the use of a good sea wire, was to apply the method of elimination ahead of the primary of the receiver. Considerable improvement in the ratio of signal to stray was obtained by placing a low resistance of value between 1 and 25 ohms across the primary of the receiving set. It will be remembered that the receiving sets were standard Navy long wave tuners and, therefore, had a series condenser, and that in ground wire work the tuning of the primary is dependent only upon the constants of the primary and not upon the length of the ground wire, the only exception being when exceedingly short ground wires are used. There is also probably some slight deviation from the rule when working with short waves around the optimum wire length. The placing of the shunt around the primary therefore did not in any way affect the tuning of it. The improvement in signal-to-stray ratio obtained by the use of the shunt is at the cost of considerable diminution in signal strength and is not therefore of very great value in improvement in readability except in special cases. It having been determined that the sea wires had twice as good a ratio of signal to stray as the rectangles, it seemed likely that one ought to be able to balance the strays from a rectangle against those from a sea wire and still have some signal left over. This was first attempted by coupling magnetically the primary of the receiving set by means of a differential radio frequency transformer to both sea wire and rectangle. The differential transformer had one secondary coil which was in series with the primary of a receiving set and it had two primary coils, one of which by means of a series condenser was tuned to a rectangle and the other tuned by means of another series condenser and suitable loading coils to one of the sea wires. See Figure 1. As a balancing arrangement the device worked perfectly, but altho signals even of very great intensity could be accurately balanced out, it was not possible to balance out strays. It should be noted that the planes of the rectangle pointed in the same direction as the sea wire, that is towards the European stations. The failure of the experiment was, at the time, laid to a lack of exact similarity in directive properties of the two component parts of the balanced system, but it is the present opinion of the writer that the failure was due to the fact that the rectangle constitutes a relatively feebly dampt receiving system, while the sea wire is, especially for long waves, aperiodic. A similar attempt, shown in Figure 2, was made to balance a land wire against a sea wire and with the same results as far as this circuit is concerned. This is probably due to the fact that a land wire in dry soil is not so nearly aperiodic as a sea wire. If the land wire were laid in wet soil the experiment would also fail, because the ratio of signal to stray would be too nearly the same for both sides of the system. The next attempt, shown in Figure 3, was to balance by means of a small potentiometer arrangement, a land wire against a sea wire. The resistance *R* was a slide wire rheostat, various values being tried from 50 to 2,000 ohms. The idea in the arrangement of Figure 3 was that the current from sea wire to ground would be opposed in phase

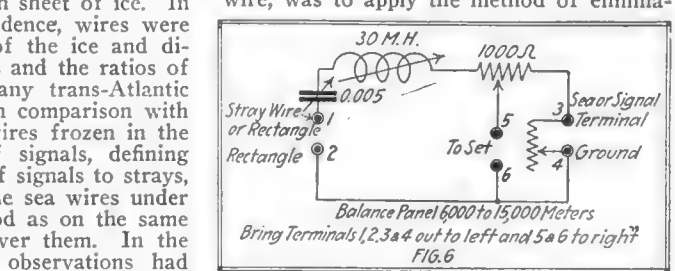


FIG.6

Design of Panel To Be Placed to the Left of a Standard Navy Long-Wave Radio Receiver; This Panel Provided the Necessary Terminals for "Sea" Wire and "Land" Wire, or Rectangles. It Also Contains the Phase-Adjusting Device in Series with the Rectangle or "Land" Wire, the Balance Resistance, and the Shunt-to-Earth on the "Sea" Wire Terminal.

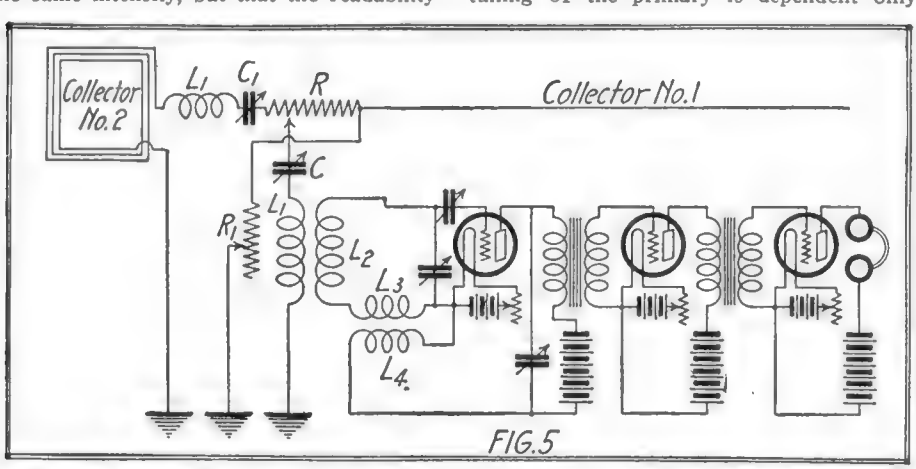


FIG.5

This Circuit Shows an Arrangement for Balancing the Loop, Collector No. 2, Which Serves as a Substitute for the "Land" Wire Balanced Against the "Sea" Wire, as Shown in the Previous Circuits. Notice That the "Sea" Wire Is Shunted Thru a Resistance R_1, Which Was Found Very Important. The Resistance R Is Sufficiently High to Give the Loop 2 a Very High Decrement.

(*Continued on page* 100)

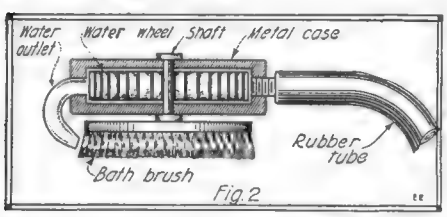
What To Invent

By JAY G. HOBSON

IN the tobacco-growing states many farms have two or more tobacco-curing barns, or sometimes called smoke-barns, that are used during the harvesting season for drying out the green leaves preparatory to selling the crop to the tobacco warehouse. The number of barns depends upon the acreage given to the valuable weed.

These hot houses are operated by the system of constructing a long flue-like fire-box similar to the common culvert of brick in use under country roads. The fore end is made open as the mouth of the furnace, while the aft end is formed into a chimney rising vertically above the roof of the barn. The heat and smoke from the fire-box are circulated thru pipes arranged around the inner wall of the barn, from where it passes into the chimney and out into the air. The green tobacco leaves are hung to long horizontal poles and placed in tiers, one above the other until the barn is filled. A thermometer is fastened inside the door to register the temperature. A fire is built in the fire-box to supply the heat required for proper treatment of the moist tobacco. Here is where the wearisome work begins that is very important. For two days and nights some member of the family must sit up and fire these barns in order to carefully guard the temperature therein, which cannot exceed 100 degrees Fahrenheit. The sap in the stems of the leaves has to dry out gradually.

The third day the temperature is raised slowly until 160 degrees Fahrenheit is reached, at which degree it is maintained until the charge of tobacco is thoroly cured.



What's the Matter With This Idea? Instead of Simply Pouring the Water Over You, Why Not Put the Water to Work—by Causing It to Drive a Small Water-Wheel, and Thus Rotate a Bath Brush. The Same Water Would Come Out and Flow Right Thru the Brush—a Sort of "Multum in Parvo."

The above work necessarily occurs in the hottest months of the year, and it is extremely tiresome keeping the fires going without sleep.

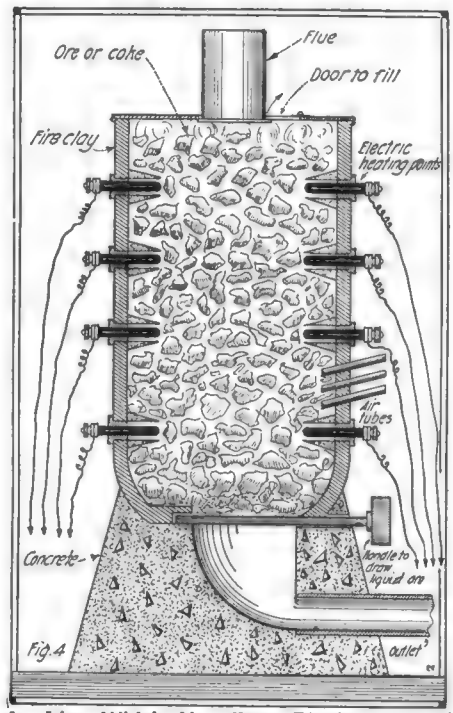
A needed improvement on this system could be introduced to tobacco growers with great success, making big money for the inventor. The accompanying illustration designates my suggestion for a practical improvement along this line. Fig. 1.

An attachment for the fire-box of the barn in the form of a coal-bin located outside, above the opening in the furnace, a chute leading from the coal-bin into the fire-box, a furnace door with a trap or draft door in the face of it for controlling the fire, an electric thermostat temperature regulator secured inside the barn and connected by a small wire to the draft gate on the furnace door.

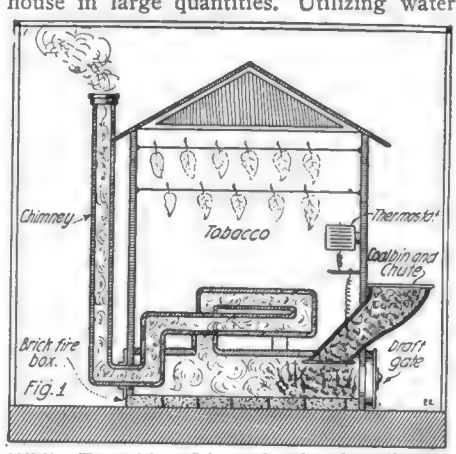
The owner sets the thermostat controller at the desired temperature, fills the coal-bin, builds a fire and leaves the night work to the mechanical fireman, resting assured his tobacco will not be spoiled; and probably obtaining better results because of the precision employed by the new improvement.

Did you ever dive into the bath and discover there was plenty of soap and water but no brush to massage the soap over the body? To be sure, but possibly the following idea has never appeared to you as being of large commercial value. An improvement in bath brushes is in order. One constructed of a small metal case, round in contour, embracing a handle connected to a rubber tube, a water drive wheel supported therein by a short shaft, and a small opening would be made for the outlet of the water upon the round brush secured to the drive shaft. See Fig. 2.

In operation the rubber tube is fastened to the water faucet, the water is turned on, the water wheel is rotated rapidly, causing the brush to revolve, thereby massaging the soap over the skin, giving a cleansing more satisfying than any device in use nowadays. An improvement of this kind would be a splendid agents' article, selling house to house in large quantities. Utilizing water



An Idea Which Has Been Playing Around My Cranium for Some Time Is Here Illustrated in the Form of an Electric Concentrating Furnace for Ore. At the Present Time the Ore Is Past Thru Several Different Complicated Machines in Order to Separate the Various Minerals, Etc. But Why Not Put the Whole Mass of Ore Into a Large Electric Furnace, Melt It All Down, and Draw It Off at the Bottom?



While Travelling Thru the South, Where Have Seen a Large Number of Tobacco "Smoke Houses," It Has Often Occurred to Me That Much Labor Could Be Saved by Substituting an Automatic Thermostat Connected to the Coal-Bin and Chute, So as to Feed the Fire Automatically. At the Present Time, Some One Has to Watch It Continually.

Copyright—1920—by the author

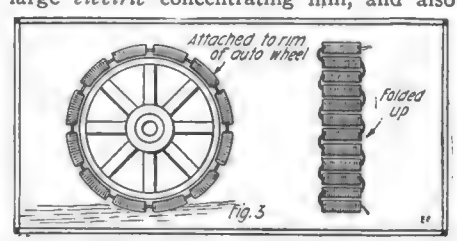
power for operating the brush would eliminate the ever-present danger of fatality when electricity is employed around water.

Many motorists experience the difficulty of repairing a puncture or changing a deflated tire when driving in the country thru mud, rain and snow. To continue driving on a flat tire not only ruins the casing and inner tube, but depreciates the stability of the car in withstanding the bumps over rough roads when running on the rim of the wheel.

This can easily be improved upon thru the instrumentality of a simple rim arrangement as illustrated in Fig. 3. This attachment is made of flat metal or wooden blocks surfaced with solid rubber and joined movably together to allow it to be folded into a compact size when not in use. When desired it can be quickly unfolded and placed around the wheel, providing caterpillar feet, somewhat like the traction arrangement on several well-known autotractors.

The merit of this improvement rests in the fact that it can be stored under the seat when not in use and applied promptly when needed. It would be of great assistance in giving trackage in soft ground, and eliminates the necessity of changing tires when driving under unfavorable conditions.

While spending a wonderfully pleasant vacation in the great mountains of the West I chanced to visit a producing copper mine using the very latest machinery for treating the copper, gold and silver ore which were the valuable minerals of this mine. The superintendent kindly showed me thru the large *electric* concentrating mill, and also



Forty Miles from Home, With a Hopelessly Blown Tire, Spells Disaster, or Something Like It. You Motorists Know! What's the Matter With Having One of These Link Belts, Comprising a Series of Solid Rubber Feet, Carried Under the Rear Seat—and In Dire Emergency, Yank It Out and Strap It Around the Wheel. Home You Go, Smiling! Next!

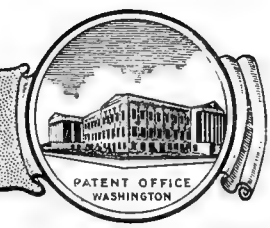
thru the mine workings bulging with "pay ore."

In the course of our instructive conversation about the habits of the red metal he explained, in detail, the simple process employed in concentrating the ore. Concentration, he said, meant separating the values in the rock from the rock itself brought up, combined, in the act of mining it.

In the mill there were found a host of costly machinery for concentrating the ore. At the head of the mill, where the ore first enters, is a giant gyratory crusher that swallows big chunks of ore the size of a man's head. This powerful machine kept crunching, biting and breaking these big pieces of ore until they were broken into hundreds of smaller stones about two inches in size. These numerous particles of rock past thru the bottom of the crusher onto a conveyor belt that carried them to the mouth of a massive revolving ball mill, horizontal in position, and similar in looks and operation to the long tubular washing machine in the public laundry. Inside of this herculean machine were hundreds of steel balls about the size of the popular baseball. The total charge of balls weighed over seven thousand pounds. The reduced size ore, to-

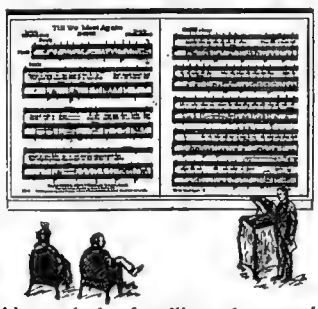
(*Continued on page* 70)

LATEST PATENTS



Music-Selling Device.

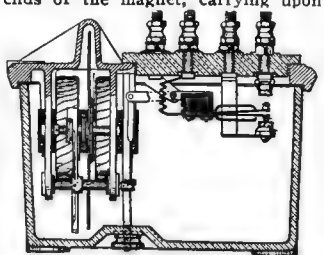
(No. 1,331,254, issued to J. M. Goudelock and R. E. Weinberg.)

The inventor of this device has certainly combined some logic with

his method of selling phonograph records and sheet music, by allowing a person to see the sheet of music and hear it, but still not handle, stating, as he does, that the desire to own a piece of music is diminished in proportion to the length of period during which the buyer is handling and reading the music, as during that time the individual handling that music is practically the owner. Essentially, the device consists of a series of racks from which large music sheets are suspended. Other racks hold these sheets in a rolled-up position like curtains. The phonograph record and the display of the sheet of music are operated simultaneously.

Alternating Current Relay

(No. 1,333,070, issued to Oscar S. Field.)

In this A.C. relay a revolving non-magnetic disk rotates between the ends of the magnet, carrying upon

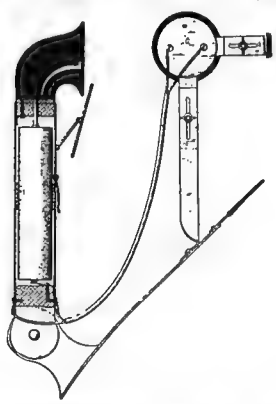


its bearing a pinion. This pinion engages a rack-like device, which allows for a lever-like movement. On conversion of this movement, thru grafite contact points, the circuit is closed or opened.

Instrument for Use of Music Teachers.

(No. 1,331,053, issued to Bertrand de Bernyz.)

This device is for instructing vocalists and elocutionists, and enables them to hear the effect of their own voices, the same as tho heard in an auditorium. A transmitter having a battery in its body is strapt on the chest. Cords lead to a telephonic head-band, one end of which has a rubber cushion so as to close one ear

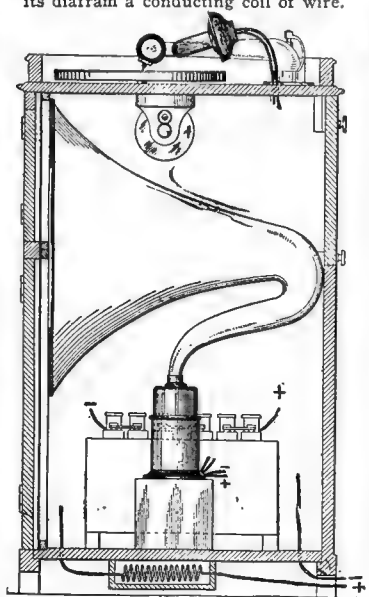


effectively cutting out all undesired sounds. In this way the student can, via the receiver, hear his own voice and correct any defects.

Sound-Magnifying Phonograph.

(No. 1,329,928, issued to E. S. Pridham and P. L. Jensen.)

In this invention a microphone is attached to the reproducing chamber of a phonograph and the microphone transmitter connecting to the amplifier, a means being embodied whereby the sound volume may or may not be amplified, as desired. The receiver itself has attached to its diafram a conducting coil of wire.

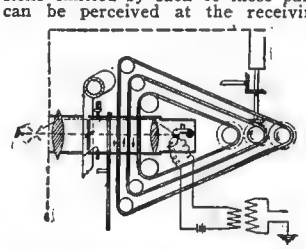


This coil is held at right angles to the lines of force of a magnetic field created by a horseshoe electro-magnet. Thus, a variation in current passing thru the said conducting coil (caused by different sound waves) will react against the lines of force of the magnetic field, resulting in a vibratory action upon the diafram.

Telephotographic Apparatus.

No. 1,329,688, issued to André D. J. A. Voulgre.)

This apparatus relates to television and telephotography. The invention is based on the principle that the division of an image into a plurality of parts and the successive transmission of luminous impressions emitted by each of those parts can be perceived at the receiving

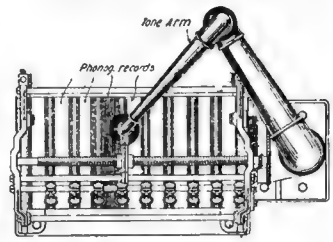


end, due to the rapidity of their reception allowing in that manner a retention of the entire picture by the eye. A light, such as emitted by a mercury vapor lamp, is used which is interrupted by a revolving shutter having longitudinal slits therein, and three other shutters having horizontal slits. These latter are belt-like; two of them revolve in one direction and the other in the opposite direction. The light emitted from these causes the object to be cut up into a series of transverse and vertical bands. At the receiving end an amalgam, made up of sodium and rubidium, is contained in a vacuum tube, which assists in reconstructing the image. Both apparata must, of course, be driven in synchronism.

Plural Record Phonograph.

(No. 1,326,473, issued to George W. Bowers.)

The record holder itself constitutes part of the amplifying horn, altho, rotating about its longitudinal axis

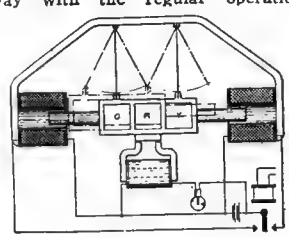


carrying the records at the same time. This will do away with a large portion of the amplifying horn in present use in phonographic machines. In operation the needle of the reproducer is lifted at the proper time and led to the desired position on the succeeding record, due to the action of cam protuberances which are separately and adjustably mounted. It is then released and the second record commences to play.

Light-Signal.

(No. 1,333,046, issued to Herbert B. Taylor.)

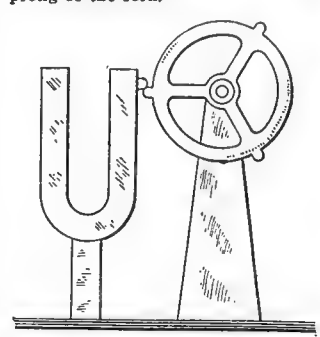
This inventor employs only one light and three screens. These screens are actuated by a two-way relay which energizes a solenoid at either end, causing the filters to swing over to a different position. A magnet at the bottom prevents oscillation of the swinging arm, carrying the filters and core of the solenoid. This magnet is just sufficiently energized to prevent oscillation and yet not interfere in any way with the regular operation.



Submarine Sound Signaling.

(No. 1,331,149, issued to Walter Hahnemann.)

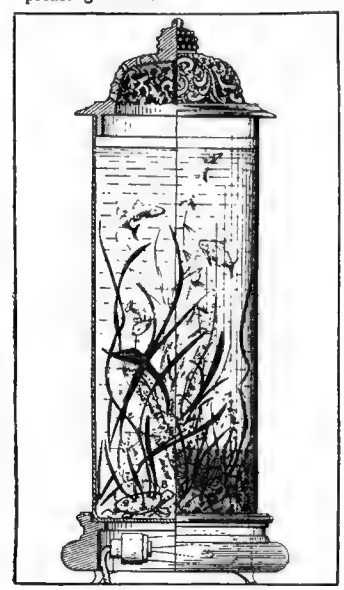
A special membranous transmitter constructed in such a manner as to transform the energy produced in the form of shocks into acoustic vibration, is the essential feature. This is very simply done by attaching a tuning fork transmitter to the membrane or diafram and then by means of a hammer, driven in any manner and regulated by a remote electric control, the prongs of the tuning fork are caused to vibrate. A body connected to the stem of said tuning fork and impinging on the water causes vibrations to be thus transmitted. Another form is to have a wheel with cam teeth strike upon the projecting lug on the prong of the fork.



Illuminated Aquarium.

No. 1,333,454, issued to Natsuo Sato.)

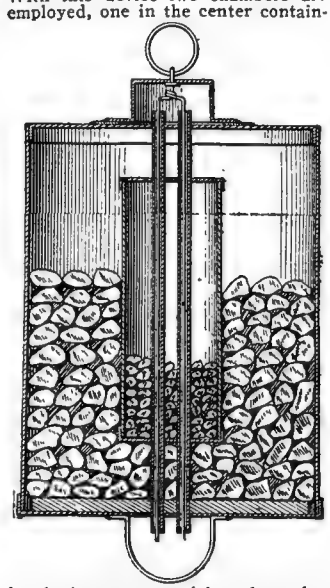
A very attractive aquarium is the result of this new invention. There is a glass container with a suitably mounted incandescent light in the bottom. No gravel is used and plants and vegetation are attached to miniature imitations of turtles, rocks or other weighted devices serving to anchor them. The light shining through the glass upon the fishes and vegetation causes a very pleasing effect.



Marine Torch.

(No. 1,333,313, issued to G. Holmes.)

Usually such torches have two chambers, one above the other, water being admitted to the chambers thru independent openings. Because of their peculiar position water is prevented from entering at times interrupting regular operation. With this device two chambers are employed, one in the center containing igniter gas material, and another one surrounding this, containing illuminating gas material. Now, when the torch is thrown into the water, the top is automatically torn from it, giving the gas a chance to escape. The two rods extending downward and sealing the entrances to the two active containers are automatically pulled out, allowing for the action of water upon the materials, thus lighting the torch.



Scientific Humor

$3.00 FIRST PRIZE

START HER IN THE ILLUMINATING BUSINESS.

Little May—"Mother, what makes my hair crackle when you comb it?"

Mary's Mother—"It's because you have electricity in it, my dear."

Little Mary—"Oh! Isn't that funny? I have electricity in my hair and Grandma has gas in her stomach!"

—S. B. Seeley.

RATHER ARCHAIC!

"Who invented the electric light?"

"Edison."

"No. Noah, he made an ark (arc) light on Mt. Ararat."

—No Name.

WATT IS?

Teacher—"Jones, name me a unit of electricity."

Jones (just waking up)—"What?"

Teacher—"Right."

—No Name.

A TRAGEDY IN THREE ACTS.

Volt.
Jolt.
Cold.

—Carl Brown.

WIREMORE OR WIRELESS?

"I see you have a 'wireless' station."

"Yes, I ordered some aerial wire from a radio concern over two months ago and I haven't received it yet."

—Doro Kantro.

SURE! DRY CURRENTS GIVE YOU A "BUN."

A—"Why did you drop that bun?"

B—"It gave me a shock."

A—"Huh!"

B—"There was a currant in it."

—J. F. Gillis.

ALL CELLS DRY SINCE JAN. 16.

Judge—"Take the prisoner to his cell."

Prisoner—"It's too damp there, my rheumatism will kill me."

Judge—"Put him in a *dry cell.*"

—Anita H. de Hecht.

THE JOB "ATTRACTED" HIM.

A—"My brother just got a good job selling electro-magnets."

B—"He must have had some pull!"

—J. F. Gillis.

SCIENTIFIC JOKE CONTEST.

OUR scientific joke contest promises to be a huge success. We print here a few samples of the first crop, and hope that you will like our endeavor. These were selected carefully from about 2,000 contributions that poured in on us, and out of 2,000 some 1,990 were more or less duplications. Out of these 1,990 there were about 1,900 with "currants" hidden away somewhere in their anatomies. We got so sick of looking at these "currant" jokes that when we look at currant pie now we are "shocked" to death. So please don't send us any more jokes with currents in them, as they will not be considered. We print a few samples to show what has been done.

Another favorite is the "watt" joke. Hundreds of these came pouring in with various variations. Then there was the "shocking" joke, with its "currants" "shocking" one to death when stept upon. Most of the jokes printed below are not new by any means. They are all of considerable vintage.

So why not try and let us have some **original** *jokes; that is what we are after. At any rate, look over the present crop and see if they will "shock" you into a smile*—EDITOR.

All jokes publisht in this department are paid for at the rate of $1 *each besides a first prize of* $3.00.

RATHER VITRIOLIC.

"Here lies William Johnson,
Now he is no more;
What he thought was H_2O
Was H_2SO_4."

—Max Goldman.

GREAT DISCOVERY.

First Professor (in high-powered motor car)—"We've got it at last."

Second Professor—"G-got w-what?"

First Professor—"Perpetual motion—I can't stop."—*The Queenslander (Brisbane).*

WHO PLANTED THIS ONE?

Smarty—"Say, pop, what do currants grow on?"

Pop—"They grow on plants, my boy."

Smarty—"But father, I mean electric currents."

Pop—"On power plants, most likely."

—S. B. Seeley.

UP TO THE MINUTE.

Jack—"My watch is the smartest around here."

Lou—"Perhaps—but it won't last long."

Jack—"How so?"

Lou—"Why, I can tell from the face of it that its hours are numbered!"

—Albert Monck.

AND TO TRANSFORMER.

Mutt—"Say, Nut, can you tell me why a woman is like a street car?"

Nut—"Give up."

Mutt—"Because it takes a man to controller."

—William Lilly.

PROBABLY BELONGS TO THE UNION—THEY ALL "NON."

Nervous Passenger (during a thunderstorm)—"Ain't it dangerous to be on a street car while it's lightning so?"

Calm Passenger—"Not at all. You see, the motorman is a non-conductor."

The nervous one felt easier.

—Paul Young.

CHEMICAL LOVE.

Said A. Tom to Molly Cule,
"Will you unite with me?"
Said Molly Cule to A. Tom,
"You're my affinity."
Under the arc light blaze,
He promised he would meet her;
BUT she eloped with A. Rascal Base
And her name is now Salt Peter.

—Lucien Tuckerman.

Trapping by Electric Shocks.

Wa-a-ll, wa-a-ll, we'll be horn-swoggled if one of our esteemed contemporaries hasn't unearthed a real, dyed-in-the-wool genius. His name is Palmer Stover—and . . . well . . . we won't say here how much we would pay this brilliant author for articles of this class. But, anyway, friends jest listen once to the tale of how Brother Stover catches foxes on an electrified wire!! Step right up, Ladies and Gents. It won't shock you—neither . . . well, read on:

"Last year I had a present made me of a small dynamo. At once I started to put into practise what I had long been contemplating.

"First I purchased a hundred feet of copper wire. Then I went to a good trapping place. At this place I dug a pit large enough to hold my dynamo and some batteries.

"I placed the dynamo, connected to the batteries and wire, in the pit. (*But, why the dynamo AND the batteries?*) Then, taking the roll of wire, I started to walk away, unrolling the wire as I went. When I reached the end of the wire I buried it in the ground. Having done this I took some staples and a hammer and fastened the wire to the ground. (*How do you get that way—Palmer.*)

One morning I found a large red fox standing on the wire. The current was strong enough to hold him fast, but not to kill him! (*Look him over, Gents! Ain't it fine?*)

He netted me fifteen dollars!!!

NOTE.—We declare Palmer Stover the foxiest ananias of the century.—Editor.

Science in Slang

By EMERSON EASTERLING

S Jazz Stokes is laid up with—well, the home brew didn't exactly agree with him—I'll try and get this month's—wait a minute until I answer the 'phone. Stokes says he'll be right up to see me. He is feeling better. I hope he didn't drink all —but that's neither here nor there.

Jazz just left—oh, you want to hear about the electrons. Well, after about an hour talking over such things as ——— ..... ——— and "?$%@, and "Sh-sh-sh, now listen to this one" we found ourselves drifting into the old rut of scientific palaver, and he opened fire by:

"The little old electron is *some* thing! The old Greeks tried to tell us that everything was composed of fire and water—some had one theory, another another, but it all went to show that the God-made-us stuff didn't satisfy their curiosity, and while they did not altogether disbelieve the propaganda as regards the source—except in the cases of individuals—they wanted to be wised up a little more as to the process; and moreso about the stuff that went to make up everything. The alchemists were sent seeking for an alkehest in which they could dissolve anything they could get their hands on. If they had found it we might be drinking extract of pig iron instead of taking nuxated steel for the all-ins.

"Anyway, when the old birds chanced upon the solution which had it that everything tangible, and some other things that we can't hardly conceive, is made up of many million funny little dufinheimers we find elucidated under the caption 'electron' in the nomenclatural dictionary, we find that the alkehest has been discovered in the sense that Sir Galahad found a certain dish; and from a field opened up by these gents of science we have in reality found material things as desirable as the all-solvent.

All About Electrons! Maybe.

"It all started when a certain guy by the name of Crookes, who carried around the title of Sir (that's nothing on us Americans, eh?) and experimented with exhausted tubes and bulbs until *he* was exhausted, found that there were an uncountable, vast, or countless number of minute particles of *something* leaves the cathode plate like a bunch of bums from a 'Men Wanted' sign. He started the big fourth dimension noise—and lifted the lid and also let a negative charged cat out of the bag—unmetaphorically, he started the searchers and researchers down the right trail toward the goal of the explanation of the wiles and ways of matter. It may not seem so, but the matter of matter, as a matter of fact, matters muchly with us.

(Second verse.)

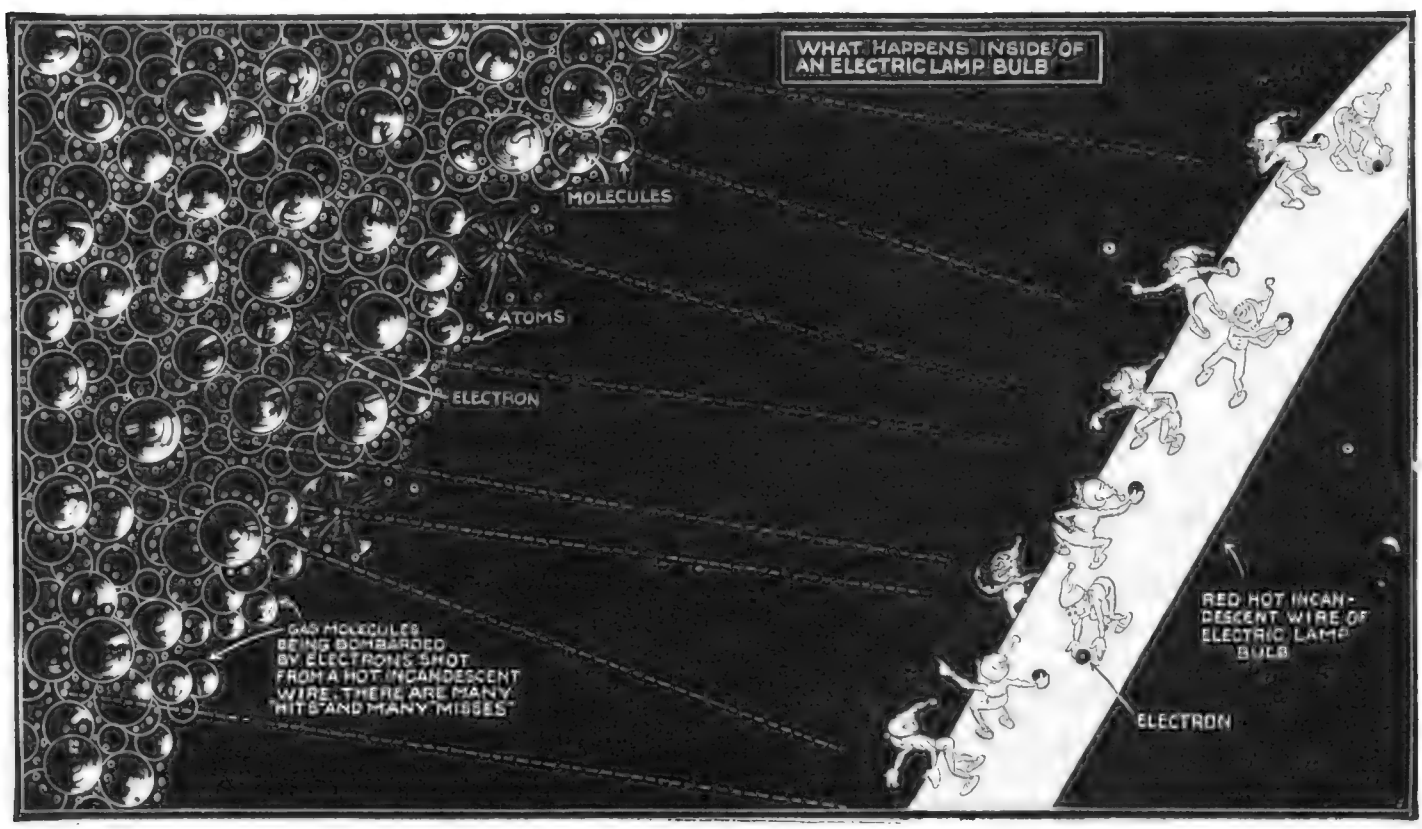
"Along about three years before the calendar manufacturers began marking 'twentieth century' on their products a gink, double J. Thomson, succeeded in making 'em believe that in spite of his implicating name, that Sir Billy Crookes was straight about the cathode rays and so forth, at least, mostly. With some sort of micrometers or diminutive yard stick he measured the electron and told 'em it was about one-thousandth the size of a normal full grown hydrogen atom, which, up to this time occupied the Tom Thumb chair in scientific circles. By capturing one of the elusive electrons and tying a speedometer to its tail and by also timing them with stop watches he found out that they generally galloped along about at the rate of anyway from twenty thousand up to fifty thousand miles per second; all of which was somewhat in excess of the speed limit at that time.

"The guys that tried to get acquainted with the little 'find,' found that there were lots of them emitted from arcs, from surface of glowing metals, from metals exposed to ultra-violet rays—and even from that light that you are in the act of applying at the end of that cabbage rope in your face." (I was lighting a cigar.)

"The electron," he continued, sniffing beggingly at my "smoke." I extended one. "The electron seems to be an indivisible unit of electricity. They have a charge of four hundred and fifty-five quadrillionths of a coulomb. Later scientists have remeasured the electron—by better methods or a finer yard stick—and find that it is one thousand, seven hundred times as minute as the hydrogen atom.

"Lord Bill Kelvin takes up the trail and sets down his deductions and discoveries and everything in a neat little volume with 'Aepinus Atomized' printed on the cover. Lorentz predicted, and Zeeman verified experimentally, that a magnetic field effected light; then Albert Einstein comes along

(*Continued on page* 87)


WHAT HAPPENS INSIDE OF AN ELECTRIC LAMP BULB
MOLECULES
ATOMS
ELECTRON
GAS MOLECULES BEING BOMBARDED BY ELECTRONS SHOT FROM A HOT INCANDESCENT WIRE. THERE ARE MANY "HITS" AND MANY "MISSES"
RED HOT INCANDESCENT WIRE OF ELECTRIC LAMP BULB
ELECTRON

POPULAR INTERPRETATION OF THE ELECTRON FAMILY

To the Right We See a Red Hot Filament in an Incandescent Lamp. Each Second Millions of Electrons are Shot Off From This Filament at a Speed Approaching That of Light. These Electrons are Now Thought to Have Mass and are Shot Into the Rarefied Atmosphere of the Exhausted Bulb. Even in the Most Perfect Vacuum that Man Can Make, There Still Remain Thousands and Thousands of Gas Molecules Inside of the Bulb, and in Their Bombardment, the Electrons are Shot Right Thru Molecules or Atoms, but Sometimes There is a Miss, and the Electron Passes Between Them and Hurls Itself Against the Glass Wall of the Bulb.

THE ORACLE

The "Oracle" is for the sole benefit of all electrical experimenters. Questions will be answered here for the benefit of all, but only matter of sufficient interest will be publisht. Rules under which questions will be answered:

1. Only three questions can be submitted to be answered.
2. Only one side of sheet to be written on; matter must be typewritten or else written in ink, no penciled matter considered.
3. Sketches, diagrams, etc., must be on separate sheets. Questions addrest to this department cannot be answered by mail free of charge.
4. If a quick answer is desired by mail, a nominal charge of 25 cents is made for each question. If the questions entail considerable research work or intricate calculations a special rate will be charged. Correspondents will be informed as to the fee before such questions are answered.

NEW DYNAMO DESIGN QUERY.

(1042) John Lunstra, Paterson, N. J., asws:

Q. 1. Why not design a dynamo without the large, expensive commutator on the armature, and use instead a simple small one for reversing the field coil polarities?

A. 1. It is hard to tell sometimes just what a certain proposed design of dynamo-electric machine will do when one cannot test it out under laboratory conditions, but from previous knowledge of the design of such machines, it would seem that no one has ever seriously proposed or applied a design of direct current motor or generator in which the armature is stationary and the field poles are rotary, the commutator being here utilized to control the direction of current past to the field coils. This is so for certain well-known technical reasons, among which are the following:

As you probably know, the "break" current induced when a field coil circuit is opened, has a very high E.M.F. or voltage which will establish a very considerable arc. The reason for this high induced E.M.F. and arcing when the field circuit is broken, is due to the great number of turns of wire in that they possess a very high self-induction. The second feature which influences this arcing, is dependent upon the rapidity with which the break takes place; the more rapid the break, the higher the induced E.M.F. and the shorter its duration. This high E.M.F. generated in the coil at the opening of the circuit, is very liable to puncture the insulation of the windings, or the insulation from winding to iron core. In all power stations or wherever dynamos are used of over 50 K.W. capacity, and even in smaller sizes, special precaution has to be taken in opening the field coil circuit, so that the high induced E.M.F. in the field at the break of the circuit may be absorbed by a high resistance. Special *field-break switches* are designed and used for this purpose with auxiliary contact blades on them. You can readily imagine what would happen if you were to hook up a commutator in the fashion you show thru a series of high inductance field coils. You would have a series of long arcs on the commutator segments, which would burn away the edge of the bars very rapidly, and in fact you would have a great deal of trouble in blowing them out at all unless you used comprest air as in the old Wood type arc lighting machines. In the second place the high induced E.M.F. in the coils as the circuits were rapidly broken in possibly 1/50 to 1/100 second would puncture the insulation of the coils between turns and the strain on the windings would be constant and persistent.

This philosophy is exemplified by a consideration of the electrical quantities predominant in the modern dynamo and motor. Here you will see on reflection that the armature coils have a very low self-inductance, and secondly the induced current at the break of the circuit as the commutator rotates is low also.

RELATIVE EXPANSION OF GASES.

(1043) L. Saunders, Tofield, Alberta, writes this department:

Q. 1. Do all gases expand equally on account of their units being constructed in the form of a spherical lattice work?

DOLLARS FOR JOKES

A SCIENTIFIC magazine is supposedly notorious for its dry reading. Still we flatter ourselves that the ELECTRICAL EXPERIMENTER can hold your attention without your yawning too frequently.

Of course you like to laugh—we all do. Sometimes we make you smile while you peruse the EXPERIMENTER. Perhaps sometimes you laugh out loud—at some of our "preposterous ideas" which we print here. And then of course the joke's on us, because we were real serious!

Now it occurred to us that we would like to print a column of real, original jokes every month, but here's the hook: The joke must be a SCIENTIFIC JOKE. No, this is no joke, we mean it!

Anyone can print or re-print jokes, but we want them with a dose of science. So, till further notice we will pay $3.00 as a monthly 1st prize for the best joke, and $1.00 for each other one we print.

So you will know what we mean with a "Scientific Joke," we print one here, which we purloined from the "Baltimore American":

LOGICAL.—"I want some good current literature."
"Here are some books on electric lighting."

Now of course, our readers can do much better than this. So let's wait and see. One reader can submit as many jokes as he pleases. Even if it is old the joke is not necessarily barred or condemned. There is one rule however: The joke must not be too technical; in other words, it must be readily understood by anyone. Not more than 100 words can be used. Use only one side of the paper.

Address
SCIENTIFIC JOKE EDITOR,
Care of this publication.

A. 1. As to whether all gases expand equally, particularly on account of the fact of their spherical lattice work structure, we are not in a position to say as to whether or not the gases expand equally when heated, because of this fact, as it is mostly a theory as yet; but, however, it is a well-known physical fact that all gases expand alike or very nearly so when heated.

As Sir Henry E. Roscoe says in his "Lessons in Elementary Chemistry": "Solid and liquid bodies expand much less over equal increments of heat and gases; they also expand differently, while all gases expand alike, or very nearly so. It has been found by exact laboratory experiments that all gases expand 1/273 part of their volume at 0° C. for every increase in temperature of 1° C., and this is known as the Law of Charles. 1/273 equals .003665; thus one volume of air at 0° C. becomes 1.003665 volumes when heated to 1° C."

SIZE AND WEIGHT OF THE EARTH.

(1044) A. D. Ward, Jr., New Bern, N. C., writes the *Oracle:*

Q. 1. Asking several questions about the earth's weight:

A. 1. The earth is about 7,920 miles in diameter, not exactly spherical, slightly flattened at the poles. The polar diameter being nearly twenty-seven miles less than the equatorial, its density is about 5.53 times that of water, according to the best data obtainable, and its mass is 6,000,000,000,000,000,000,000, six thousand millions of millions of millions of tons. The earth's surface in square miles is 197,000,000 square miles. The air pressure on the entire surface will be the area multiplied by 14.7

According to Flammarion, the weight of the earth is 6,833,000,000,000,000,000,000 tons. And the atmospheric pressure on the same is 6.151,000,000,000,000 tons. Even tho the earth appears to be very rough, nevertheless it is quite the other way; that is to say, it is smooth, a good deal more so in comparison than the skin of an orange.

The ether of infinite space is not supposed to have any weight. This has been demonstrated by obtaining as nearly perfect a vacuum as is possible. If all the air could be exhausted, there would still be ether left, which we presume corresponds to the ether of infinite space.

As a demonstration that there is some substance which we call ether present we would advise that a ray of light be shot toward the container, from which all the air has been exhausted. It will be found that this ray of light will actually pass thru and be seen on the other side, much the same as the rays of light come thru an exhausted tube such as an electric light bulb, and as no light ray can be propagated thru space without the agency of some medium, there must be some medium in the bulb which we call *ether.*

SELENIUM CELLS.

(1045) W. S. A., Schenectady, N. Y., asks:

Q. 1. Some questions on selenium cells.

A. 1. It is a known fact that selenium cells vary considerably as regards their quality as well as their electrical resistance, it being possible to obtain cells of the same size for any resistance between ten and one million ohms, and also the cell may remain in good working condition for several months while another will become useless in as many weeks.

The ability of a cell to respond to very rapid changes in illumination, to which it is exposed, is due largely to its *inertia,* it being a known fact and verified by experimentation that the higher the resistance of a cell the less the inertia, also the greater its sensitiveness. The effect of

(*Continued on page* 66)

JOHNSON'S CARBON REMOVER

In

YOU can keep your motor snappy and full of "pep" by ***preventing*** the accumulation of carbon.
Don't wait until your engine is choked and caked with it. Use Johnson's Carbon Remover every 500 miles, then the carbon is removed while it is soft and powdery, eliminating the frequent grinding of valves and ***keeping*** the motor ***always*** clean. No experience or labor required—you can easily do it yourself in ten minutes—and the cost is trifling.

Easy — Clean — Safe — Quick

Johnson's Carbon Remover is the easiest, cleanest, safest and most satisfactory remedy for carbon. It will save you from $3.00 to $5.00 over any other method without laying up the car. A dose of Johnson's Carbon Remover, the engine laxative, will stop that knock—quiet your motor—save your batteries and reduce your gasoline consumption 12% to 25%.

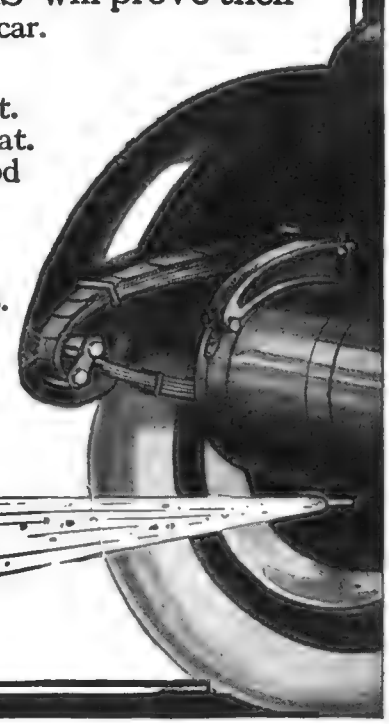
Keep Your Car Young with Johnson's Car Savers

Start today to reduce the depreciation of your automobile. An hour or two every month and JOHNSON'S CAR SAVERS will prove their value in dollars and cents when you come to sell or turn in your car.

Johnson's Radiator Cement—liquid.
Johnson's Stop-Squeak Oil—a wonderful spring lubricant.
Johnson's Valve Grinding Compound—gives a velvet seat.
Johnson's Cleaner and Prepared Wax—make body, hood and fenders look like new.
Johnson's Black-Lac—the perfect top dressing.
Johnson's Auto-Lak—a splendid one coat body varnish.
Johnson's Hastee Patch—can be applied in two minutes.

Write for our folder on "Keeping Cars Young"—it's free.

S. C. JOHNSON & SON **Dept. EE-5** **Racine, Wis., U. S. A.**



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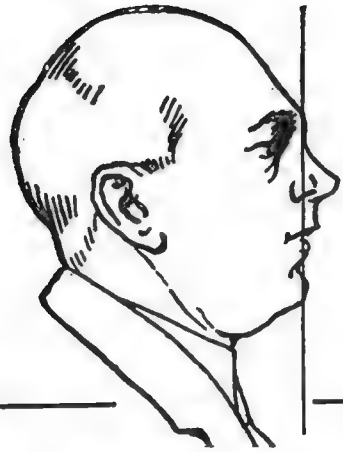

Learn How to

Know Men!

—to sell them
—to employ them
—to direct them

HAVE you ever lost an order in selling? Picked the wrong man for a position? Found it a problem to direct some men successfully? Of course you have! Why? Because **"you did not know your man."**

Mistakes in judging human nature are vital and seriously affect one's success in the business and social world.

No one has given an equally direct, simple method of judging men as has Mr. Wilson M. Taylor, Sales Efficiency and Employment Expert in his new book,

"The Science of Approach"

The Key to Men's Minds

Mr. Taylor classifies the various types of men and shows you the best way to quickly appraise the minds of men of various types, to determine their inclinations, their process of thinking, their basis of judgment and decision.

He tells you why people like you or do not, how to handle the procrastinator, to know the type of man who thinks and acts slowly, the type of man who thinks and acts quickly, the type of man who is emotional or non-emotional. To know these facts is to know in advance the proper way to approach men of all types so as to sell them, or to judge them so as to employ or direct them successfully.

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Name .....

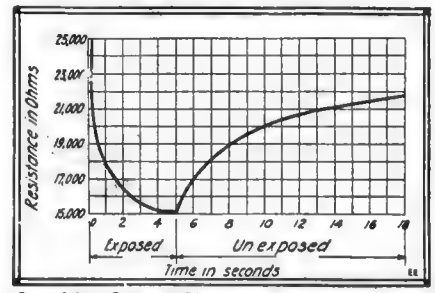
Address .....

E.E. 5-20

The Oracle

(*Continued from page* 64)

inertia can be readily seen by attempting to make a graph of the time it takes the cell to respond to light and the time of recovery. This is known as a *lag.* This can be greatly reduced by enclosing the cells in an exhausted glass tube. Not only will this decrease the *lag* in the cell, but also prolong the life of the cell considerably. Continued illumination projected on a cell causes a permanent defect which is generally known as fatigue, the cells then becoming very sluggish in their action and their sensitiveness gradually becoming less. The maximum sensitiveness of a selenium cell is toward the yellow-orange portion of the spectrum and hence light of that color will have a direct effect upon a cell. Likewise heat has been found to vary the electrical resistance of selenium in a very remarkable manner. At 80° C. selenium is a non-conductor, but up to 210° C. the conductivity increases, after which it again diminishes.



Graphic Curve Showing "Lag" of Selenium Cell or Time for Recovery.

All we could advise in this matter is that you either build your own selenium cells or enclose them in an exhausted glass tube and attempt to keep the cells covered when not experimenting with them. Perhaps a *photo-electric* cell would meet your need more exactly than selenium.

A Bullet-proof Searchlight Reflector

By EDWIN F. LINDER, M.E.

(*Continued from page* 19)

It was of vital importance that something be done to safeguard the searchlight equipments from the ever increasing wave of destruction to which they had ben subjected.

An American engineer, who had specialized for many years in the use of searchlights under very novel circumstances, gave this difficult problem very serious thought and toward the close of the war conducted a series of tests that resulted in the production of a device which he named the "Bullet-Proof Mirror." This device was experimented with in model form under similar conditions to those which might be expected on the battlefields; smaller apparatus was employed, of course, than would be operated under actual military engagements, nevertheless this new departure in searchlight methods gave very satisfactory results.

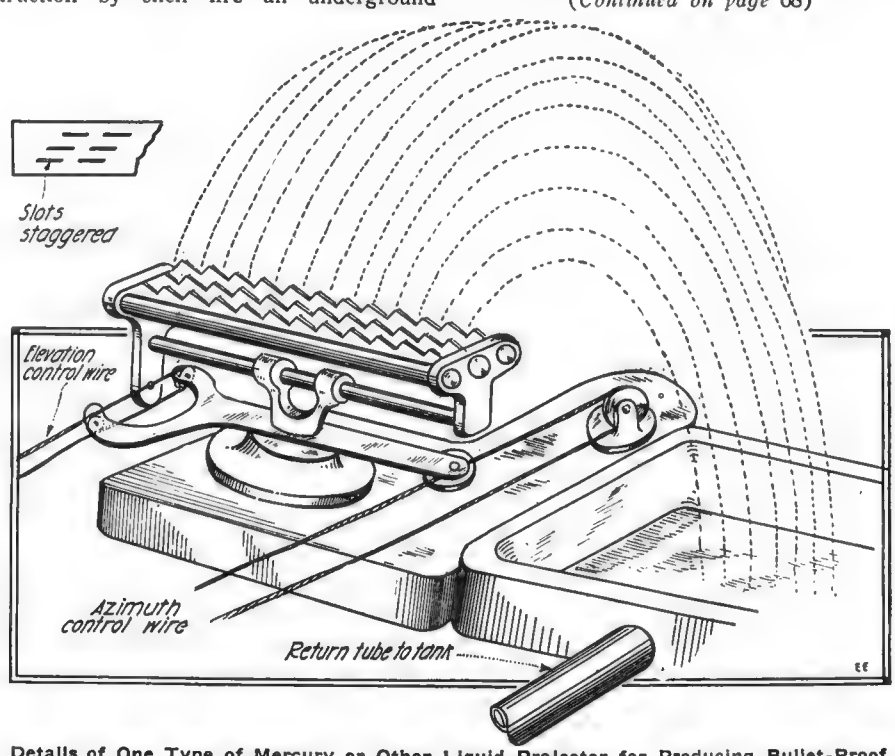
To insure absolute protection against destruction by shell fire an underground chamber, the roof of which is approximately thirty feet below the surface, is excavated at the end of an inclined tunnel. This chamber contains the major part of the projector and generator units and many of the auxiliary mechanisms used in conjunction with the new liquid reflector apparatus, which is set up at the upper end of the inclined tunnel, referred to above. A second dugout, somewhat similar to the larger chamber, is provided for the men controlling the operations of parts of the outfit at the new mirror.

The apparatus creating the flat *fluid reflector* is possibly of more interest than the others and is of very simple construction.

DETAILS OF THE "BULLET-PROOF" MIRROR.

Three tubes, closely fitted together, have attached to the upper surfaces a series of

(*Continued on page* 68)



Details of One Type of Mercury or Other Liquid Projector for Producing Bullet-Proof Mirrors.

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Get into this paying profession and have positions opened to you by manufacturers, architects, railroads, contractors—by every kind of a corporation where mechanical design and construction are carried out. Draftsmanship puts you in the class of specialists, raises you above the crowd of job hunters, makes you a man whose services are needed.

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EASY PAYMENTS

Low tuition fees and easy terms of payment. Pay as you go along. Get training which will soon repay in extra earnings all the cost of the course. You know the salaries received by skilled technical men today. Get information on the opportunities which are opened wide to you by Chicago "Tech". We will give you all this information about fees, terms, etc., and send testimonials from Chicago "Tech" graduates on how they have profited from our instruction, if you will send the coupon.

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Other institutions ask you to pay first—and then to find out later how well qualified you are for this profession. We send the free lesson first and place you under no obligation at all. Discover your qualifications before you pay anything. And see for yourself just what Chicago "Tech" offers you in training which will bring a ready market for your services and open opportunities which are closed to the untrained man. The coupon will bring all the facts about the course, the small fee, and the easy terms.

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BEATS GASOLINE AT 15 CENTS A GALLON

New Invention Makes Fords Run 34 Miles on Gallon of Gasoline. Other Cars Show Proportionate Savings.

A new carburetor which cuts down the gasoline consumption of any motor, including the Ford, and reduces gasoline bills from one-third to one-half is the proud achievement of the Air Friction Carburetor Co., 382 Madison St., Dayton, Ohio. This remarkable invention not only increases the power of all motors from 30 to 50 percent, but enables everyone to run slow on high gear. With it you can use the very cheapest grade of gasoline or half gasoline and half kerosene and still get more power and more mileage than you now get from the highest test gasoline. Many Ford owners say they now get as high as 45 or 50 miles to a gallon of gasoline. So sure are the manufacturers of the immense saving their new carburetor will make that they offer to send it on 30 days' trial to every car owner. As it can be put on or taken off in a few minutes by anyone all readers who want to try it should send their name, address and make of car to the manufacturers at once. They also want local agents to whom they offer exceptionally large profits. Write them today.—Adv.

BE AN EXPERT

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Earn $100 to $400 a Month

Young man, are you mechanically inclined? Come to the Sweeney School. Learn to be an expert. I teach with tools not books. Do the work yourself, that's the secret of the

SWEENEY SYSTEM

of practical training by which 5,000 soldiers were trained for U. S. Government and over 20,000 expert mechanics. Learn in a few weeks; no previous experience necessary.

FREE Write today for illustrated free catalog showing hundreds of pictures men working in new Million Dollar Trade School.

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6000 Mile Guarantee

UNION TIRES represent the highest standard in reconstructed tires. Their reinforcement of 4 extra layers of fabric reduces greatly blowout and puncture possibilities. Over 200,000 in use. To further increase mileage, we include with every tire ordered A **PUNCTURE PROOF TUBE FREE** that under ordinary conditions will last ten to 20,000 miles. Our 5,000-mile tire guarantee certificate with every tire.

Prices Include Tire and Tube

30x3	$7.40	32x4½	$12.00
30x3½	8.50	33x4½	12.50
32x3½ S.S. only	9.10	34x4½	13.15
31x4	10.35	35x4½	13.40
32x4	10.70	36x4½	13.85
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Reliner Free With Every Tire

State whether you want straight side or clincher, plain or non-skid. Send $2 deposit for each tire ordered, balance C.O.D., subject to examination, or 5 percent discount if full amount is sent with order.

UNION RUBBER COMPANY
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PERSONAL MAGNETISM WINS!
No difference what you want, use it. Worth more to you than all else besides. "How to Win" 362 pp. $2. "How to Hypnotize," Complete Manual of Instruction, 126 pp., illustrated, $1. "Health Culture" Insures Vital Strength 25c. Address, Science Inst., D.E. 6435 N. Clark, Chicago.

Bullet-proof Searchlight Reflector

(*Continued from page* 66)

narrow slotted nozzles, which are so arranged that the ends overlap one another. It is thru these nozzles that thin flat ribbons of fluid are sent upward, producing the *Bullet-Proof Reflector,* discharging finally into a collector at the end of the tubes. From here the liquid is returned to the storage tank to replenish the supply and make it possible to maintain a constant spray screen at the nozzle tubes.

The mechanical features permit the changing of the angle of the nozzle tubes, thereby giving considerable scope to the elevation and lowering of the projected beam. It is also so constructed that the device may be rotated in azimuth; this allows the operator to direct the sweeping light beam over considerable territory on either side of it.

During the early stages of experiment, mercury was adopted as the substance for creating the reflector, but this was found to be impractical for many reasons. Finally a substitute was employed which was better suited for the purpose. This was *a strong solution of silver nitrate,* to which were added a tartrate, ammonia water and ground glass. The chemical process of obtaining the desired quality of reflective strength which this solution contains cannot at this time be disclosed.

The many advantages of this device are easy to comprehend; however, it might be stated that as the projector and reflector stations are quite remote from one another, it is exceedingly difficult to locate the initial source of the ray. This being nearly a hopeless task, it gives almost perfect protection for the major portion of the plant and its attendants. Only by chance would it ever occur that the reflector unit could be damaged and as this can be readily replaced, not much loss would be suffered in time or cost.

The most important benefit gained is the continuous operation of the outfit, the beam being in constant play, defying the hail and storm of the foe's bullets throughout the dark of night.

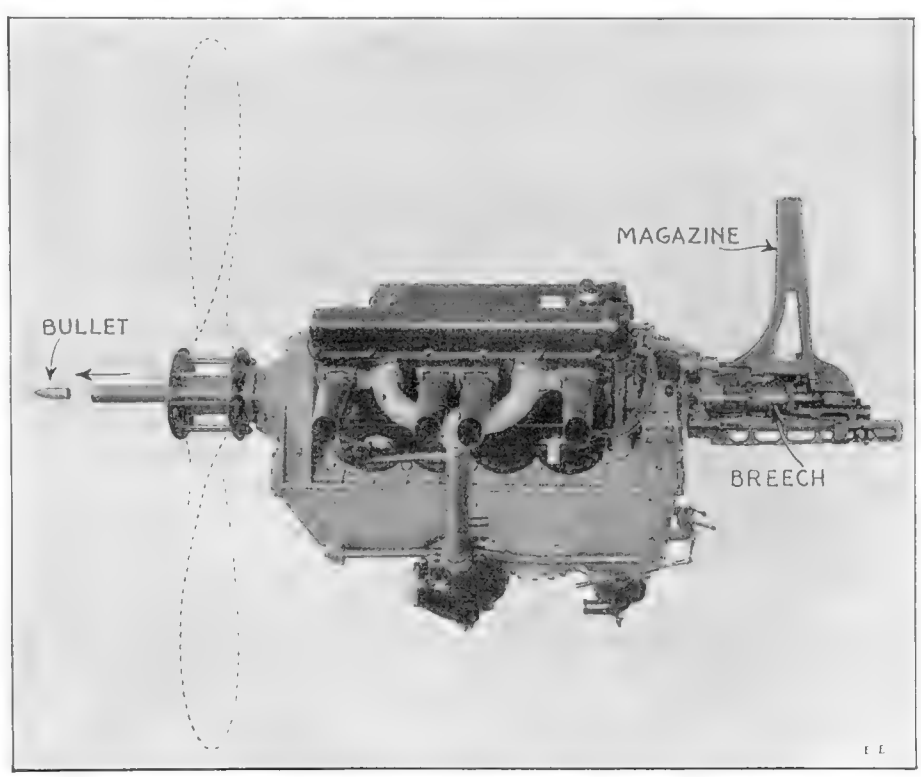
Such an apparatus would indeed have baffled the coolest heads, who after having destroyed thousands of the other types would be at a loss to understand why this mysterious target did not give way under concentrated range firing by their foremost marksmen.

Not being able to destroy this new type of equipment as quickly as the old, the time thus gained to replace the latter would have finally brought about a complete lapse in night attacks; in other words, it would have placed the Bullet-Proof Mirror corps in a position to flood the enemy lines constantly with light sufficient to make it impossible to make any surprise attacks that would be successful. Thus making perpetual daylight of the night would certainly have been an obstacle that no foe, however brilliant in the art of military strategy, could surmount without long previous preparation.

New York Aero Show

(*Continued from page* 32)

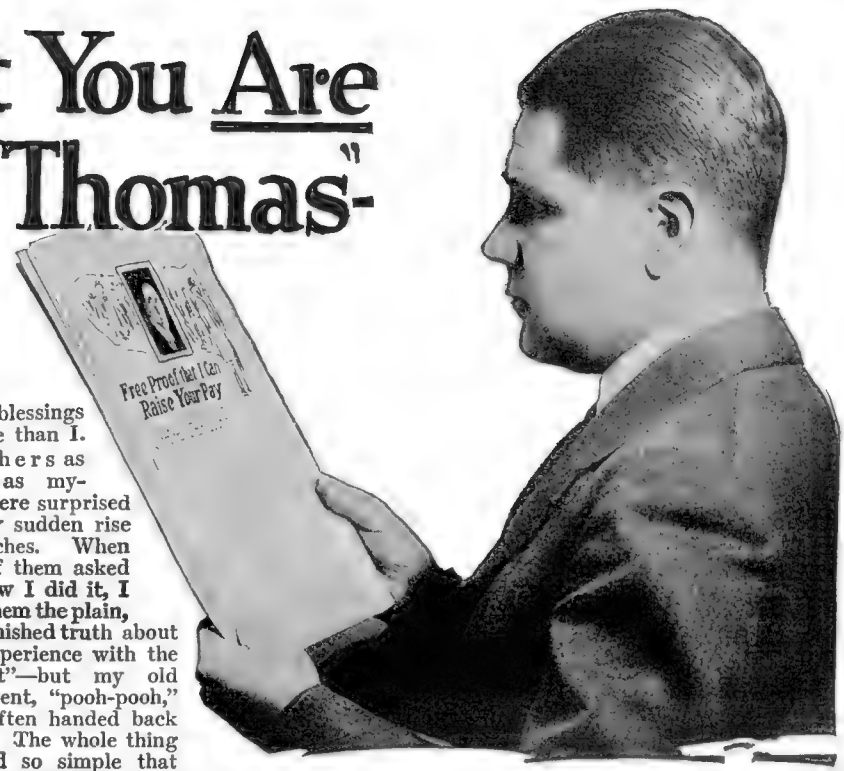
This giant flier attains a maximum speed of 110 miles on hour and can climb 6,000 feet in nine minutes. It can carry 3,000 pounds of mail on long flights, or 6,000 pounds on short ones. It carries a crew of two pilots, one radio operator and one mechanic, besides the large weight of mail above mentioned. It has a cruising radius at low speed of 16 hours, and at high speed, 10 hours.



This New Wright-Hispano "Cannon Motor" for Airplanes Has a Thirty-Seven Millimeter Automatic Cannon, Which Was Developed by the U. S. Ordnance Department, Shooting Thru the Propeller Shaft. The Engine Is Also Equipt With Two Synchronizer Attachments for the Operation of Additional Quick-Firing Guns.

I Hope That You Are a "Doubting Thomas"-

--because that gives me my chance to prove that I can raise your pay.



NO matter how much money you are making now, I can show you how to earn more—much more.

That's a strong statement, isn't it? Perhaps you doubt it? I hope so, for I *know* what it means. And it will give me just as much pleasure to prove it to *you* as I experienced when I proved it to myself.

Make me prove that I *can* raise your pay. Here I am in Meriden, Connecticut—Albert L. Pelton—ready and willing, yes, and happy to do it—but it's to be *entirely at my risk and expense.*

That's fair, isn't it? It's as fair as if I offered you a horse, and refused to accept a cent until you had driven him a month—and found him sound in wind and limb.

If you *are* a "Doubting Thomas"—one of the people who keep on reading, and disbelieving, my advertisements—here is your chance to make me make good in your case.

I'll tell you why I'm so positive about this. There are two reasons: First, I was convinced after being a doubter myself—and second, because 400,000 other people have been. Thousands of them were literally lifted from poverty to riches by the surprising power of the "secret" they learned from me. One of them gave me the title, "The man who makes men rich." It has stuck to me because it's true. That's why it's not handing myself a bouquet to admit its truth.

As I said, I was a "Doubting Thomas" about this "secret" myself. I was a plain, unassuming, *poor* man when I heard of it. I was deply in debt. I was "eye to eye" with black despair. I had had failure after failure; it seemed as if everything I touched became "hoodooed."

One day I met a man who told me the "secret." But at that time I didn't recognize its amazing power. In answer I advanced an argument which seemed unanswerable to me—I said "pooh-pooh." Afterward I did some hard thinking and made up my mind that if the "secret" was a humbug I would investigate it and expose it.

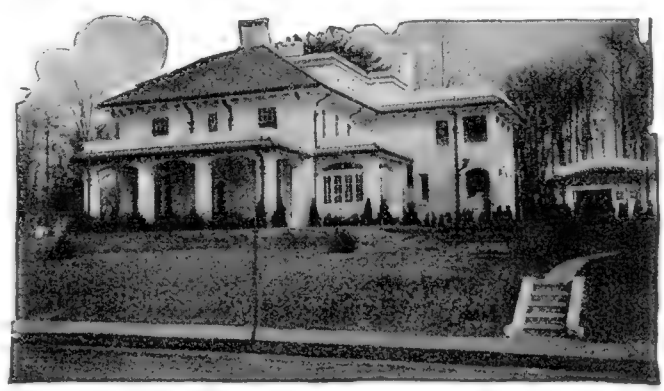
The more I thought about the secret, the more I realized that here was the truth I had always lacked. I began to use the secret. It was a good time to test its power, for I was flat broke.

From the first I was thrilled with a new sense of power, but I was afraid to believe that my tide of misfortune had turned, until opportunities, and money, actually flowed in on me. Things I never believed I could do became easy as turning over my hand. My business tangles straightened themselves out, and I began making money at a rate that made me gasp! "Doubting Thomas" Pelton was convinced at last.

Now I have money, a beautiful home for which I paid $50,000 cash, I go traveling when I want to, and I have besides a wealth of friends. Few people have more of the real blessings of life than I.

Others as well as myself were surprised by my sudden rise to riches. When any of them asked me how I did it, I told them the plain, unvarnished truth about my experience with the "secret"—but my old argument, "pooh-pooh," was often handed back to me. The whole thing seemed so simple that some of these inquirers never investigated farther. I am sorry for them, for those who did, gained results from the secret that were simply astounding!

One of the men who overcame his doubts, and put the book I furnished him to work in his life, rapidly rose from a rank failure to a position that paid him $600 a week. He visited me in my summer home on the coast of Maine last season and told me that he had just been made president of a 16-million-dollar corporation.



Mr. Pelton's Residence in Meriden, Conn.

And listen to this:

In a little town in New York lives a man who two years ago was pitied by all who knew him. From the time he was 14 he had worked and slaved—and at sixty he was looked upon as a failure. Without work—in debt to his charitable friends, with an invalid son to support, the outlook was pitchy black.

Then he learned the "secret." In two weeks he was in business for himself. In three months his plant was working night and day to fill orders. During 1917 the profits were $20,000. During 1918 the profits ran close to $40,000. And this genial 64-year young man is enjoying the pleasures and comforts he little dreamed would ever be his.

I could tell you thousands of similar instances. But there's no need to do this, as I'm willing to tell you the "secret" itself. Then you can put it to work and see what it will do for *you.*

I don't claim I can make you rich overnight. Maybe I can't do it at all. Sometimes I have failures—everyone has. But I do claim that I can help 90 out of every 100 people if they will let me.

The point of it all, my friend, is that you are using only about one-tenth of that wonderful brain of yours. That's why you haven't won greater success. Throw the unused nine-tenths of your brain into action and you'll be amazed at the almost instantaneous results.

Develop your will-power and money will flow in on you. Rich opportunities will open up for you. Driving energy you never dreamed you had will manifest itself. You will thrill with a new power—a power that nothing can resist. You'll have an influence over people that you never thought possible. Success—in whatever form you want it—will come as easy as failure came before. And those are only a few of the things the "secret" will do for you. The "secret" is fully explained in the wonderful book, "Power of Will."

How You Can Prove This At My Expense

Send no money—no, not a cent. Merely clip the coupon and mail it to me. By return mail you'll receive, not a pamphlet, but the whole "secret" told in this wonderful book, "Power of Will."

Keep it five days. Look it over in your home. Apply some of its simple teachings. If it doesn't show you how you can increase your income many times over—just as it has for thousands of others—mail the book back. You will be out nothing.

If you pass this offer by, I'll be out only the small profit on a three-and-a-half-dollar sale. But you—you may easily be out the difference between what you're making now and an income several times as great. So you see you've a lot—a whole lot—more to lose than I.

Mail the coupon or write a letter now—you may never read this offer again.

SPECIAL NOTE

In nearly five years the price of "Power of Will" has been increased only 50c. We find it necessary now to raise the price to $4.50 as soon as the present edition is gone. This means that by July 1st or sooner the price must be increased to $4.50.

Pelton Publishing Co.

30-J Wilcox Block Meriden, Conn.

Pelton Publishing Company,
30-J Wilcox Block, Meriden, Conn.

You may send me, "Power of Will" at your risk. I agree to remit $3.50 or remail the book to you in five days.

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For One Dollar

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How to enjoy your wireless station by getting what is coming to you!

All of this, without a teacher, in your spare time, with a little effort, and at almost *no expense!* That is what our course, entitled, "How to learn Telegraphy (either code) without a Master, by the "Phonetic Memorizing System" will do.

HUNDREDS have written us as follows:

Please find enclosed ten dollars for the course, "How to Learn Telegraphy Without a Master, by the Phonetic Memorizing System," sent to me on trial. After I had tried for years to become an operator without the desired result, thanks to the Phonetic Memorizing System I am now employed as an operator with the C. N. R. (Signed) J. Crackle.

ANOTHER WRITES: I have been in the employ of the C. P. R. for six years, and although I have worked my way up to chief delivery clerk, I could not succeed to learn telegraphy. I bought your course, and now I can copy thirty-five words per minute easily on the mill. The course has just worked as you stated it would. The Phonetic Memorizing System is a corker. (Signed) E. W. Thomas, Calgary, Alta.

A typical letter we received from Mr. T. T. Hamilton, operator at Pacific B. C. He writes: You should have heard my wife's opinion of your Phonetic Memorizing System as applied to the teaching of Telegraphy, when I handed her my first pay check.

(This man, from a warehouse helper at fifty dollars monthly, and a sick wife and big family, with the aid of our course in his spare time, and **on credit**, has become a divisional station agent with a **fat income.**)

We have qualified with the aid of the Phonetic Memorizing system in one single term one hundred and fifteen students, and raised their combined monthly incomes by $19,895.00.

The full course, worth its weight in gold, costs ten dollars, and we will send you same on free trial, you to be the judge.

To defray expenses for mailing, correspondence, etc., pin a one dollar bill to the coupon, and we will forward the full course without delay.

If after two months you are satisfied that the course has done for you what we claim, send us TEN DOLLARS, we will then register you in our free employment office. We secure positions for our qualified students.

GO TO IT. DO IT NOW.

CANADIAN SCHOOLS OF TELEGRAPHY AND RAILROADING
314 Catherine St., West Montreal, P. Q., Canada

To The Treasurer of "The Canadian Schools of Telegraphy and Railroading," 314 St. Catherine Street, West Montreal, P. Q., Canada.

Dear Sir:—Please forward to me for a two month's trial your course, "How to Learn Telegraphy Without a Master, by the Phonetic Memorizing System." I will give this course a fair trial, and if after two months it has done for me what it claims it will I promise to send you ten dollars. Otherwise I will not be under the slightest obligation to you.

Name .....

Address .....

Reference .....

What to Invent

By JAY G. HOBSON.

(*Continued from page* 60)

gether with oil and water, was fed into the mouth of this mill, where the rapidly pounding steel balls chewed it into a million fine particles of pulverized stone in the form of muddy water.

As the mill revolved the momentum carried the charge of balls upward, threw them around, across and down, inside, like some mighty hail storm of metal. The detonation caused by this constant pounding of steel against steel was deafening, but indicative of the fine work being done by this great machine.

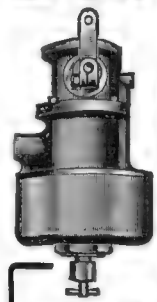
The powdered ore, now in the form of muddy water, came out the lower end of this ball crusher into a trough where a special device classified the mud. The larger particles of ore were separated from the smaller and returned automatically to the ball crusher for regrinding. The properly ground ore ran down the trough into a box-like machine with vertical mixers or beaters that churned this combination of copper, gold, silver, oil and dirt very much as butter is churned. These machines were called floatation cells, getting their name from the peculiar method used to save the ore values. The oil in the water when stirred rapidly formed bubbles or a froth that had a special affinity for the copper, gold and silver metal but not the waste rock. This oil froth acted like a magnet to the mineral, the copper, gold and silver flakes united with the oily froth, the air in the bubbles raised it to the surface of the box where slow-moving paddles skimmed the valuable froth off very much the same as cream is skimmed from milk.

Another trough carried the froth over steam pipes in the drying bins, where the oil and water is dried out, leaving a rich black powder called concentrates. While this is the most efficient ore treatment known to science today, yet it is not all that mining men desire. These concentrates must be hauled miles to the smelter that has the facilities to separate the three metals from each other. The smelters of today use a very slow and expensive system of ore separation which calls for a needed improvement in ore treatment as shown. One operated entirely by electricity that would concentrate and separate the ore at the mine, all in one and the same operation. My suggestion is in the shape of a large blast furnace operated by great electric heaters that will reduce the mixture of coke, copper, gold, silver and rock to a liquid mass. The heaviest metal naturally would gravitate to the bottom first, then the next and on until only the waste slag remained to be disposed of. A practical invention of this kind would soon revolutionize the mining industry. It would be the needed means of making hundreds of dividend paying mines from the many that are working at a loss because of the excessive cost of operation and handling of their low-grade ore.

An invention of this description will go down in history as one of the greatest, ranking with the threshing machine, the automobile, the binder and the electric power in value to mankind. While it may require years to accomplish the above it surely will be done some not distant day. The fame and fortune assured from the perfection of the above is well worth the effort and sacrifice necessary to obtain it.

A new use for the aeroplane has been found in the conveyance of material for the construction of a wireless telegraph station in the far interior of China.

SAVE 1/2



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31x4	8.75	36x4½	14.50
32x4	9.50	37x4½ (Cords)	25.00
33x4	10.50	35x5	14.75
34x4	11.75	36x5	15.00
32x4½ (Cords)	15.00	37x5	15.50

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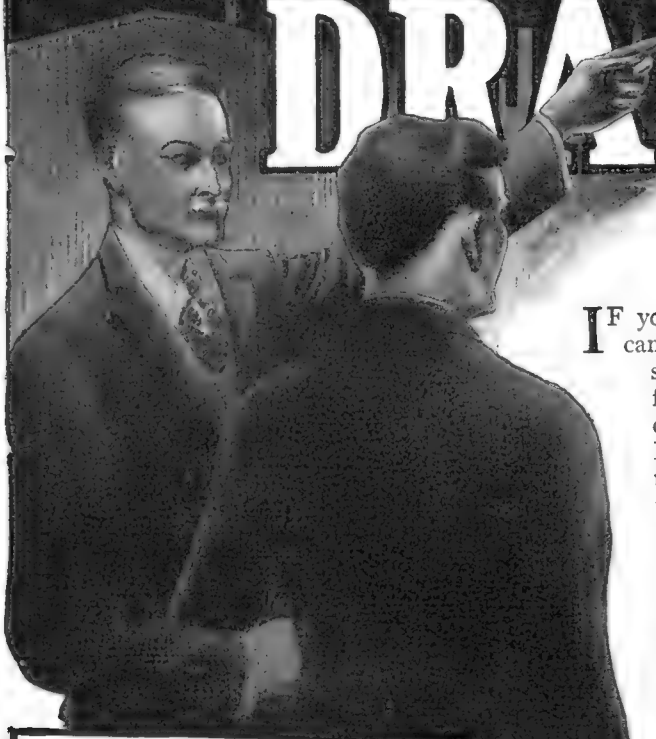

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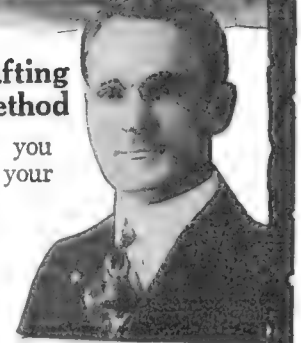

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No Previous Training Required

As our students are given practical Drafting work from the beginning of our course, no previous training or drafting experience of any kind is required to take up this work with us. The training we give you is all that is needed to secure a position as Draftsman. (See Laurence Johnston's letter).

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(More letters on request)

"I have accepted a position as draftsman, paying $2,640 a year to start. I had no previous drafting experience aside from my training with you, which has proven all that was needed for me to become a professional draftsman."—Laurence P. Johnston. (Mr. Johnston is making as high as $200 a month extra in his spare time, which makes his total income from Drafting over $5,000 a year.)

"Several firms have offered me $40 and $45 a week to start. As I am doing nicely as draftsman up here and about to receive my second increase in salary, have decided to stay. I find that there are hundreds of openings for draftsmen and if I quit where I am I could secure another position in three hours' time. There will be a still greater demand for Draftsmen."—Geo. Murray, Jr.

"I wish to express my appreciation for your courteous treatment and sincere interest in the progress of my studies and for aiding me upon completion of your course, to secure a very desirable position at $140 a month to start. I am getting on well and the chances for advancement are excellent."—A. L. Gash.

"I have accepted a good position with a large manufacturing concern in Chicago and wish to thank you for the training your school has given me."—Emil B. Johnson.

A few of our many other successful graduates are: *G. Tangorra,* $2,800 *a year; T. R. Brown,* $2,860 *a year; R. Fowkes,* $3,700 *a year.*

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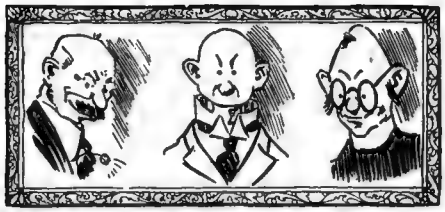

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Popular Astronomy

By ISABEL M. LEWIS, M.A.

(*Continued from page* 43)

plication arising from the fact that the velocity is varying and becomes zero at the center. A body falling along any other than the polar shaft, *in vacuo*, would be affected by the earth's rotation in such a manner that it would describe the arc of a spiral curve, the law of motion being extremely complicated. All that can be said in regard to the deflection under such circumstances is that the body would be thrown toward the *Eastern* wall of the shaft and after falling only a distance of two hundred miles along an equatorial shaft an object would hit the eastern wall unless the width of the shaft was about two and a half miles.

Consider now the effect of *air resistance* upon the motion of the body.

Within the polar shaft (which is the only case we can consider owing to the complications arising from the effect of the earth's rotation upon the fall in other shafts), the air will increase in density toward the center of the earth. The density of the air in terms of the density of water at sea-level is .08. Its density at lower levels has been found by Legendre's law. (See Table.) And increases in proportion to the distance from the center of the earth. At the center its density is .33 or *one-third the density of water at the surface.* If the shaft were filled with *water* instead of air, *its density at the center would exceed that of surface rocks.*

We can compute by simple mathematics the amount of this retarding force for a ball six inches in diameter. Manifestly we cannot consider a man falling down a shaft so we will assume the falling object to be the ball mentioned above. From the dimensions of the ball we find the time values of 5^m, 10^m, 14^m, 15^m, counted from the moment the body leaves the surface by means of a formula for simple harmonic motion of a body falling in a resisting medium along the earth's polar diameter. See table. We find that the retarding force of the air is so great that the body is *brought to rest* two thousand miles below the surface about fourteen minutes from the time it started. The velocity of the body and the retarding force of the air are equal at this point and amount to approximately 23,000 feet per second or four and three-tenths miles.

After the body has been brought to rest it will start to fall again with a new velocity which will be that for the point where it is brought to rest. It will encounter greater air resistance than before and be brought to rest again. This process will be repeated indefinitely. Each time the velocity will be less and air resistance stronger until finally air resistance will overcome permanently an extremely weak attraction and the object will remain buoyed up by the air a short distance from the earth's center.

As a matter of fact the tremendous velocity acquired long before this point is reached would cause the body to be completely consumed by air friction.

Table showing, for various depths, time of falling thru a shaft *in vacuo* (along polar axis), acquired velocity, and corresponding resistance, body would meet in air; as well as force of gravity for different depths, and density of air, water and earth material (according to Legendre's Law).

Table showing, for various depths, time of falling thru a shaft in vacuo (along polar axis), acquired velocity and corresponding resistance, body would meet in air; as well as force of gravity for different depths, and density of air, water and earth material (according to Legendre's Law).

Depth	Time of Falling (In Vacuo)	Acquired Velocity (In Vacuo) Ft. per Sec.	Air Resistance (For Ball Six Inches in Diameter) Ft. per Sec.	Density of Earth	Density of Air in Shaft	Density of Water	Gravity Ft. per Sec.
At Surface..	.....	.....	.....	2.65	.08*	1.0†	32
7,500 ft.....	22 sec.	693	7	2.7	.08	1.0	32
270 mi....	5 min.	9,450	1,580	3.5	.10	1.3	30
1,050 mi....	10 min.	17,610	9,860	5.9	.18	2.2	24
1,480 mi....	12 min.	20,250	15,210	7.0	.21	2.7	20
2,030 mi.*..	14 min.	22,680	22,730	8.5	.25	3.2	16
2,225 mi....	15 min.	23,340	25,030	9.0	.26	3.4	14
Center of Earth....	21 min. 3 sec.	25,940	39,640	11.2	.33	4.2	0

*Note that a body falling in air will be stopt even before this point is reached by air resistance. (7,500 ft. approx. greatest depth yet reached by man).

†All densities are relative to density of water at surface.

Note: Water at earth's center would be more dense than surface rock, and density of air at center would be one-third that of water at the surface.

Oddities of Sound

By H. WINFIELD SECOR

(*Continued from page* 18)

Thus, if we know the time elapsed between the origination or start of a sound wave and the exact time when it strikes our ears, and as we know the velocity of sound travel thru the air, 1,132 feet per second, all we have to do to determine the distance of a locomotive steam whistle, for example, is to watch when the steam escapes from the whistle, and then by means of a stop-watch (or an ordinary watch) count the number of seconds it takes the sound to reach us. The writer has often done this while standing on a high mountain at the base of which a railway wended its way. It is a very interesting experiment, and one that any person can easily perform. To get exact results the stop-watch should be started (or the counting of the second hand on the ordinary watch started) when the steam is first seen to escape from the whistle, as it will be the sound caused by this first escape of steam that you will hear when it has reached you. As soon as you hear the very first sound, the stop-watch key is closed, and the elapsed time taken note of. The air line distance to the whistle or train will then be the number of seconds elapsed, multiplied by the velocity of sound, or 1,132 feet per second for 70° Fah. See Fig. 4.

THE STORY OF THE ECHO.

We have all been amused and perhaps startled in our younger days, when walking thru a tunnel or visiting a cave where we found that, if we talked, whistled or sang, after a short period we could hear our voice repeated in the form of the well known *echo.* The echo is a common phenomenon in the physics of sound, and is caused invariably by the reflection of the originating sound due to its striking some acoustically reflecting body such as rock, wood or other material suitably arranged so that one or more of the reflected sound waves impinges on our ears. See Fig. 5.

(*Continued on page* 74)

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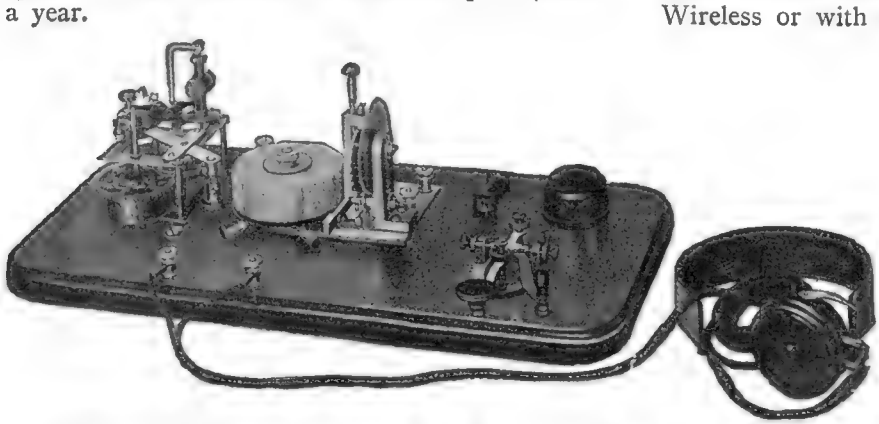

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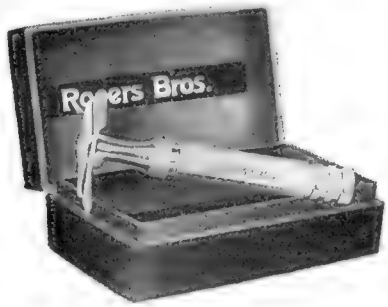

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Oddities of Sound

(*Continued from page 72.*)

THE UNMUSICAL PARLOR.

Possibly you may have had some experience in the direction of musical or rather we should say *unmusical* metal picture frames, glass vases, brass candlesticks, chandeliers, etc., which possess the undesirable property of vibrating in sympathy as certain musical notes are played on the piano or organ. He remembers particularly one dastardly brass picture frame measuring about 10 by 15 inches, which reclined gracefully on its easel atop the piano. Every time the note one octave above middle "C" was struck, this frame sizzed and zizzed for several minutes and caused such an horrible discord that it had to be removed each time the piano was played. At another time a glass vase committed the same criminal offense and had to be removed from the piano. Practically every little object in the room where a piano is situated responds to sympathetic vibration whenever a note or chord is sounded on the piano which corresponds to the fundamental note or frequency of the object in question. Altho it need not necessarily be the fundamental note that is played which causes the trouble, but even a harmonic will do it. The brass tongs and other trimmings surrounding the open fireplace often prove offenders as well as metal piano lamps, chandeliers, stoves, loose window panes, etc. See Fig. 6.

(*To be concluded.*)

The Amateur Magician

By JOSEPH H. KRAUS

(*Continued from page* 44)

sometimes—various other things, and is comparatively cheap, financially speaking. The model hand of wax is carefully balanced so that it is just a little heavier at the wrist than at the finger tips. The finger tips have been drilled open and iron cores inserted into two of them, the wax, of course, being carefully smoothed over the holes made for these cores. Iron wire answers the purpose very well. Of course, a hand must be obtained which will have a peculiar position such as shown in the photograph which you have there. This allows for a reasonable rocking motion and results in the subsequent raps.

"The table is arranged practically the same as in various other stunts of mine, namely, two wires travel up the legs and terminate at the top in an electromagnet 6 inches long, 4 inches in diameter, having a 1-inch core. This is wound with No. 18 D. C. C. magnet wire, making quite a powerful magnet and inserted in the table as shown in the diagram. When an electrical contact is made thru to a storage battery conveniently located by means of switches or buttons well within reach, sufficient magnetism is created to tip the hand over on to its finger tips and cause it to tap out the desired answer, the glass table not affecting or disturbing the magnetic effect. The buttons as you see are connected in parallel to the same wires and so placed that I can move around and yet control the hand without it being noticed. There is no skill required in the making of the table and its wiring is simpler yet. The contacts in the legs are arranged so that the table may at all times be moved without creating suspicion and yet when placed over the floor plates immediately becomes operative.

(*Continued on page* 87)

In one of my talks a few months ago, I explained how advertising reduces prices. The advertising manufacturer does business so much more easily and in such larger quantities than his competitor that he can pay for his advertising, make a substantial profit and still sell you his goods for less.

The many concerns who spend thousands of dollars for space in the ELECTRICAL EXPERIMENTER every month, don't do it for love of the magazine! They do it because it costs them less to sell their goods with advertising than without. That's why they continue to advertise.

Since it costs them less to do business, they can naturally give you better prices.

But even if you didn't save a cent by buying advertised goods, even if they cost you more (which they never do for the same quality), it would pay to trade with advertisers. No manufacturer can afford to advertise an unreliable product or service!

The immediate results of any advertising seldom pay for its expense. In order to make advertising pay, it must secure regular customers. Those manufacturers therefore, who advertise regularly month after month in the ELECTRICAL EXPERIMENTER, *must* be securing regular customers, and *must* be giving their customers complete satisfaction.

Many of you will probably remember the famous "7 point" gum that was so widely advertised a few years ago. Why did that advertising campaign fail? Not because the advertising wasn't good,—it was excellent.

The trouble was, the *gum* was no good. People bought it once, but they didn't *keep on* buying it.

This is just the point I am trying to make about the firms who *keep on* advertising in the EXPERIMENTER. The fact that their advertisements appear continuously shows that they, unlike the chewing gum people, are *keeping* their customers, by giving them prompt service and their "money's worth."

An additional protection you enjoy when ordering from the EXPERIMENTER'S advertisers is that the publishers reject all advertising in any way misleading or objectionable.

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Advertising Manager.

ONE ON EDISON.

Years ago Thomas A. Edison used to try to instill the rudiments of science into the head of his young son and never overlooked an opportunity to use some every-day happening to illustrate some principle of mechanics. On this particular occasion, chancing to spy a peddler pushing a handcart, the great inventor cried: "Now there's a good example. I don't suppose you can tell me why he pushes the cart instead of pulls it. I don't know whether the man himself could answer. I'll ask him."

"My good man," said the inventor, turning to the peddler, "why do you push the cart rather than pull it?"

"Cause I ainta da hoss, you damma fool," was the unscientific, tho disconcerting answer.—San Francisco *Argonaut.*

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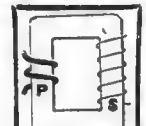

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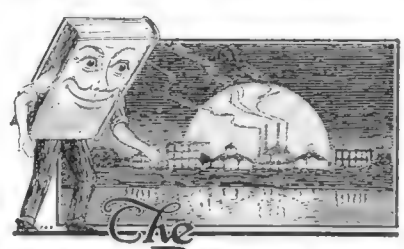

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Cutting the Boche Electrified Barbed Wire

By VAN LOUIE MARTIN

(*Continued from page* 15)

the French were relieved and completely out of the sector. Compare this with when five weeks later the French troops relieved us in this sector they were with us three days and nights before allowing us to depart for the rear. I went into the lines on this front as an automatic rifleman but by the dawn of the first day I had been transferred to the Battalion Intelligence Department, or the S. O. S. platoon, and placed on observation post at once; but my experience as an observer is another story. Only a few days had elapsed when one of our scout lieutenants leading a patrol thru "No Man's Land" became entangled in the enemy barbed wire and was electrocuted. Upon the strength of this incident and probably partly due to my natural mechanical talent, I was selected as one of two from our outfit to immediately be sent to the rear to attend a French Electrical School, conducted in a small village near Gerardmer.

It was here I was taught the gentle art of cutting the enemy electrified barbed wire without danger from the current to myself, or comrades and without the enemy detecting the trick. More than once since that time have I been called upon to do this most hazardous night work. A wire cutter's outfit consists of a rubber suit of union-alls, a pair of gauntlet rubber gloves, half knee length rubber boots, an insulated "bridging" wire, and an insulated pair of wire snips of holders. The glove sleeves are worn underneath the coat sleeves and boot tops underneath trouser legs to keep out the water. Just before going on a job a wire cutter has taken from him every weapon of defense, as well as his belt, gas mask and helmet. He will have a partner to work with him and sometimes two sets of partners work together, one set holding the wire while the other cuts it. He leads a patrol over "No Man's Land" to a place of hiding near the entanglements from where they are supposed to keep him protected, while he and his partner go forward and cut a panel of the wires for them to pass thru.

The Germans electrified their wires in sections, each section being independent of the other. Connected in the circuit of each section, and located at front line headquarters, is a sensitive gold leaf detector that registers any fluctuation of the current. Trained upon each section is a machine gun, automatically controlled and connected in this same circuit. Any one cutting this wire *without first bridging the gap with insulated wire*, or who short circuits it by falling into it, or in any other manner cause an interruption of the current, will immediately cause a small bell to ring in this said machine gun emplacement and that same machine to automatically traverse that section of the wires with bullets.

The Germans usually used hydroelectric or portable gasoline plants with which to electrify their wires, and I will say here that when ever the Americans took over a sector, the current was turned into the wires of that sector much earlier in the afternoon than was customary. The Germans had a custom of placing a stumbling wire, not electrified in front of the charged wires, and it was these stumbling wires, hidden by the grass, that caused the death of our Lieutenant Carter.

In October we had our first snow and of course most all vegetation was killed but we could trace the live barbed wires quite a distance, with the aid of our glasses, by the streak of green grass that was yet growing all along underneath it.

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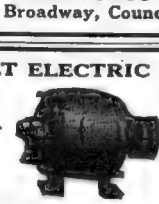

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Practical Chemical Experiments

By PROF. FLOYD L. DARROW

(*Continued from page 47*)

DETECTION OF NITRATES.

Nitrogen may also be present in the form of nitrates but, since nitrates from other than organic sources are much more common than nitrites, their presence is not so indicative of contamination.

First prepare a solution of phenol-sulfonic acid by dissolving 15 grams of carbolic acid in 185 grams of concentrated sulfuric acid. Place the mixture in a flask and immerse in a beaker of water maintained at the boiling temperature for several hours.

To make the test evaporate 100 cc. of the water to dryness in a porcelain dish placed on a water bath. Add 2 cc. of the phenol-sulfonic acid and stirring thoroly follow it with 10 cc. of distilled water and 5 cc. of ammonia water. If nitrates are present a characteristic yellow color will appear.

A simpler nitrat test can be made as follows: Evaporate 50 cc. of the water to a few drops and add 2 cc. of concentrated sulfuric acid containing a minute quantity of *brucin.* If a coloration results, nitrates are present.

ORGANIC MATTER.

In making this determination the first step is to prepare a standard solution of potassium permanganat by dissolving in one liter of distilled water 0.395 gram of the salt. Preserve in a clean, well-stoppered bottle. Also prepare a solution of sulfuric acid by pouring very carefully 18.5 cc. of the concentrated acid into 166.5 cc. of distilled water.

Then measure into a clean porcelain dish 100 cc. of the water and add 10 drops of the sulfuric acid solution. Warm the contents of the dish nearly to boiling and add from a burette, drop by drop, standard potassium permanganat solution, stirring and heating after each addition. Continue until the first permanent tinge of pink appears, i. e., a pink color that does not disappear on stirring and heating.

The organic matter in the water absorbs oxygen from the potassium permanganat, thereby decolorizing it. By taking the readings of the burette before and after the titration, the amount of permanganat solution used may be obtained and this will give an indication of the quantity of organic matter present. Each cubic centimeter of the solution used means one part of absorbed oxygen per million parts of water. More than 4 or 5 parts per million, without some known source, indicates pollution.

PHOSFATES.

Potable water will never contain more than traces of phosfates. To detect their presence evaporate 100 cc. of the water to dryness, moisten with a few drops of ammonium molybdat solution and warm gently. If a decided yellow color results, animal contamination is indicated.

To prepare the ammonium molybdat solution, dissolve 15 grams of the salt in 100 cc. of water, adding a little ammonia water if necessary to effect solution. Pour the solution with constant stirring into a mixture of 50 cc. of nitric acid and 50 cc. of water. Let the mixture stand in a warm place for several days and pour off the clear liquid.

Lead: One method of testing is to evaporate 100 cc. of the sample to 10 cc. and add a few drops of potassium bichromat solution. If lead is present a yellow precipitat results.

If another test is desired add 5 cc. of ammonia water to 2 liters and follow it with acetic acid, until the water reacts *acid* to blue litmus paper. Evaporate this to 10 cc. and pass into it hydrogen sulfid gas. A black precipitat confirms the presence of lead.

(*Next:—"Mineral analysis of water."*)

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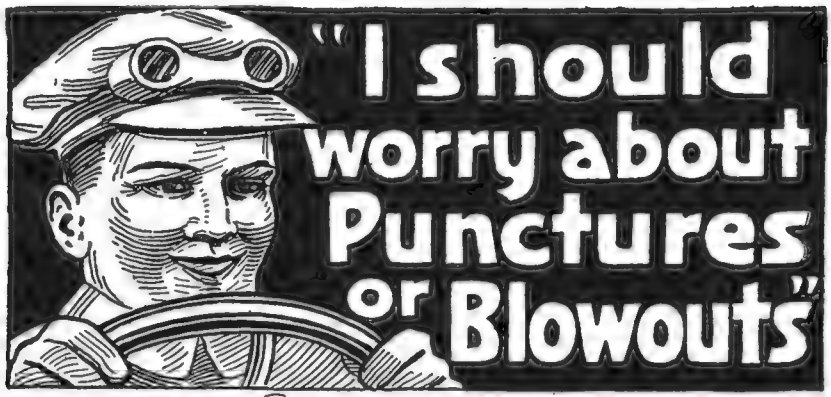

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32x3½	4.75	1.60	36x4	7.00	2.10	34x5	10.25	3.10
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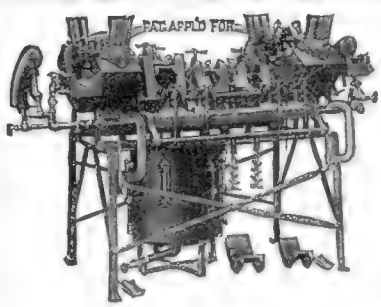

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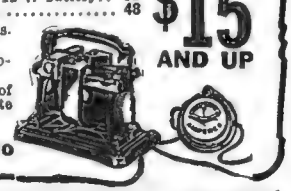

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Aladdin's Lamp

By CHARLES S. WOLFE.

(*Continued from page* 33)

time that he made his first simple bend in a piece of glass tubing heated over a Bunsen flame, until the completion of his *first successful lamp,* it seemed to Johnny that life was just one d—— hot thing after another. Glass in general, and hot glass in particular, has several annoying habits. Any one so minded can readily demonstrate this to his own satisfaction, and almost before Johnny had learned that he could easily blow a bubble of hot glass, he had found that he could even more easily burst a bubble of hot glass. Then there had been the question of *pumps.* At the outset, Johnny had known just a trifle less than nothing at all of the methods employed and the tools used to produce a vacuum. He was now a wiser, but fagged-out man. But as a reward for his labors he had built his pumps, had constructed gauges, had created bulbs, had mastered the trick of sealing in electrodes, had conquered.

Shutting the door of the laboratory behind him, he crost to the table and picked up a tube, a three electrode De Forest type bulb which he had recently constructed. Turning it over idly in his hands he fell to musing. Mentally he reviewed the features of the tube, its capabilities and its limitations. Many things it could be made to do. Many it could not be made to not do. Static, just for instance. Static! You got your signal, yes, many times amplified under the proper conditions, but the way it *amplified* static was criminal!

Why? mused Johnny, why can't it be made to ignore static any way? What is static, in the first place! The accepted theories, glib enough, raced across his mind in review. The attempts that had been made to eliminate it. Circuit after circuit, loop and buried antennae. Yes, even submerged! Now, thought Johnny, arrange your circuits as you will and your chain is no stronger than its weakest link. In trying to eliminate the static disturbance, you're almost bound to weaken the incoming signal.

A couple of nights later, he was finished, and his handiwork lay before him ready for the test. At midnight, he straightened up, disgusted. Failure, and a bad one at that. The blame thing wouldn't function at all as he expected; the results it did give were far inferior to other bulbs he had constructed. In the darkness, in bed, his body resting, but his mind refusing to call it a day, he thought on. Suddenly, as if a voice had spoken into his ear, the word "Gas" came to him. Gas! Well, he would try it.

The decision cost a couple of weeks' work. Gas after gas, from coal to hydrogen, had gone into that obstinate tube without helping matters in the least. Thoroly disgusted by now, he straightened up one night, tube in hand, his eye searching the particular spot on the wall where it would give him the greatest satisfaction to shatter the offending bulb. One of the greatest inventions of the age trembled on the brink of destruction. Then his hand fell. Combination! A couple of gases; that might be the secret. Followed more wearying work. Combination after combination failed to give the desired results.

One evening, more listless than was his wont, he came into the laboratory, prepared to give the tube another test. This time he had filled it with a previously untried combination. He connected the bulb in circuit with his conventional radio apparatus, using the same circuits for the additional electrodes that he had used thruout his experiments with the thing. He closed the antenna switch carelessly, and lit the filament, idly making other needed adjustments

with one hand for a smouldering cigarette had the other occupied. Suddenly there was a roar in the 'phones, making him jump involuntarily, then silence—dead silence.

A quick glance showed the bulb to be burning the same as before, quick readings of his meters showed what he thought to be proper voltage pressures on the various electrodes. Puzzled, he stript off the headset, preparatory to searching out the cause of this sudden trouble. Something caused him to screw off the cap of one of the receivers, and as the diafram was exposed to view he gave a whistle of astonishment. BENT! Pulling it aside, he glanced at the magnets. Suspicion waxed, and he began to test the windings. A few seconds sufficed. Startled, he laid the useless 'phones on the table. "Burnt out," he muttered.

Sadly he surveyed the wrecked headset. The only high resistance receivers in the place. Well, anything that strong ought to make some impression on a polarized relay. Suiting the action to the thought, he soon hooked a relay in the place previously occupied by the 'phones, and once more threw in his antenna switch. With the lighting of the filament, the relay at once gave up the ghost. Thoroly aroused now, he stood staring at the bulb. An inkling of the truth burst on him. He must be receiving a goodly proportion of the radiated energy of some station.

Eyes roaming over the room in quest of something to substitute for the ruined relay, his mind in a turmoil, he stood before the wonderful tube irresolute. Then, struck by a sudden idea, he grinned. Pulling open a drawer, he brought forth a little motor, designed to run on dry cells, a relic of his first experiments. Chuckling, he turned to the tube. "I guess this will hold you, old girl," he laughed aloud, and, disconnecting the uselss relay and sounder, he put the motor in circuit. Up went the antenna switch again. With a frantic whirl the armature spun dizzily. Came the smoke of burning insulation. With an oath Johnny yanked down the switch, but the motor was thru for that evening. *Wireless transmission of power was an accomplisht fact.*

Johnny Hartman dropt into a chair, and sat staring at this creation of his. He was in much the same predicament as a respectable hen, who, with all the best intentions in the world, has been tricked into bringing forth an eaglet.

A thousand unanswered questions racing thru his mind, he strove for composure and methodical reasoning. What were the possibilities of this marvelous lamp? Just what was he receiving, and from where? How could he measure the energy received, and what would have to be the capacity of the meter used? What ——? And then that queer flicker he had received in the brief instants the bulb had been functioning. Was it the fluctuation of a current of Heaven alone knew what strength? Or was it a phenomena entirely new to man?

He was seized with a desire to rush forth and find somebody—anybody—who had knowledge of this type of apparatus, and bring them face to face with this wonder. But second thought restrained him. Some idea of the possible monetary value of this invention began to dawn on him, and he was suddenly very anxious that no one should get an inkling of the things that were transpiring in his humble work shop. Despairing of getting his thoughts out of their chaotic state, and not daring to experiment farther without charting his course and feeling his way, he put out his light and went to bed. But not to sleep. Long he pondered, and some time in the night a thought came, staggering in its immensity, unthinkable, and yet——

The next morning found him incapable of going about his daily tasks. Instead he locked himself in his shop and worked feverishly all day on the queerest piece of apparatus that he had yet evolved. Fin-

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isht, it stood on the table ready for test. With trembling fingers he connected the tube and his latest product in the tentative circuit he had evolved. He dropt into his seat, and his shaking hand reached for the antenna switch. Pausing, his nervous fingers hovered over his apparatus. Long wave, or short? Deciding to try first with the longer waves, he switched in a big loading coil. His left hand closed over the handle of his aerial switch, his right reached for a snap switch near at hand. Came a click, and the room was plunged in darkness. Simultaneously the grating of the blades of the big switch sounded in the darkness.

A queer, flickering light hovered over the whole front of the big mysterious box he had given the day to building. It grew brighter, waned, grew brighter. Hartman's breathing, unknown to him, filled the room with hoarse sound. Vague shadowy blotches appeared and disappeared on the front of the new cabinet where that weird light played. Hartman was tuning frantically, inductance switches and condenser handles twirling under his perspiring touch. And then, suddenly clear cut and bright, it was there on the cabinet front, *the moving picture.*

Incredible, but no less a fact. A stately ship rode majestically thru a calm sea, the smoke belching forth from her funnels, the white foam curling under her prow. The sharp exhalation of Hartman's pent-up-breath broke the silence, as the image blurred and faded under his tuning fingers. Again and again came images, scenes close, and scenes far. On an extremely long wave, a lovely island somewhere in the Pacific had shown in riotous color for a moment, to be followed by a setting sun in some far Western state. Overcome by his emotions, unable to continue, Johnny snapt on the lights and disconnected the aerial. He realized now that on the table before him rested in very truth—*Aladdin's Lamp!*

The only way in which he could account for the phenomena he had just witnest was by the vague theory that he had formulated the night before. It had occurred to him that light rays, traveling thru the atmosphere, caused sufficient friction to set up an E. M. F.,—faint, doubtless, but definite; a current faithfully modulated by every variation of the ray that gave them birth. There came the realization of the power placed in his hands by this device for good or evil. Drunk with power, he arose, grasped a hot-wire ammeter, determined to try the reception of power once more.

As he feverishly made the necessary connections, it occurred to him that if his theory anent the light rays were correct, much of the static disturbances must be due to this source; perhaps unknowingly men had been listening to the stars for years. Chuckling over this, he tightened the last post with his right hand as he once more threw up the antenna switch with his left.

Amid the crash of falling hills and the darkness of fading light, Johnny Hartman's soul left his already lifeless body. Electrocuted by his own invention, his inert form crashed down on the table, splintering to dust that priceless bulb.

And thus they found him many hours later, his face horribly cut by the fragments of what police officer Finnegan called in his testimony at the Coroner's inquest *an electric light!*

(FINIS)

[This story is based on actual possibilities and accords with the cathode ray telephotographic apparatus for transmitting pictures by wire or wireless, as described several years ago in this journal. The theory is right and it certainly seems that if some genius can perfect the proper bulbs and auxiliary details, that "movies" via wire or radio will be as commonplace as the screen movie of today.—Editors.]

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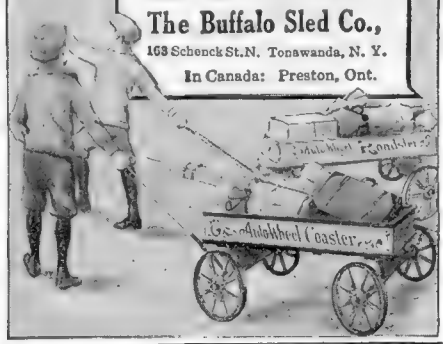

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The Electrical Machinist

By H. WINFIELD SECOR

(*Continued from page* 49)

hold on each pulley, that is, driver and driven, is very good, but where the belt becomes loose, this does not appear from the writer's experience, to be as satisfactory as the 45 degree or similar angular drive. A 30 degree drive is also very good, this lying between the horizontal and the 45 degree drive. From the 45 degree onward toward the 90 degree or vertical drive, the efficiency of belt transmission appears to fall off until it is at its lowest efficiency on the 90 degree or vertical angle. This is the poorest drive possible as careful tests have shown, and as much as 66 per cent of the power at the *driver* shaft at the top may be lost in transmission via the vertical belt drive to the *driven* shaft at the bottom.

On any size or width of belt drive the highest efficiency is always obtained when the belt is cemented or made *endless*, as it is called in machine shop parlance. If the belt is to be laced, a good pig-skin lacing is about as satisfactory as any, altho there are several very good lacing hooks on the market which work very well if properly installed. But on small drives such as bench motor work and other small machines, laced belts are not eminently satisfactory, and an effort should be made to make a cemented joint in the belt, of uniform thickness with the rest of the belt. There are available from belting and machinery supply houses various forms of clamps for holding the two ends of the belt in position while it is cut and properly tapered to make a cemented lap joint, where the belt cannot be removed from its pulleys and cemented out of its normal position, so that one can work on it. Various turns sometimes have to be made in belt drives, especially with round belts, a right-angle turn being shown at Fig. 2B.

At Fig. 2C a useful wrinkle is shown, where an idler pulley, which is usually mounted on an adjustable arm counterbalanced by a weight or else a spring, is brought into play so as to insure the proper arc of contact on the smaller pulley, where a belt drive is to be made at short range. Generally speaking, and wherever possible, the distance between centers of the driver and driven pulleys should be not less than three to four times the diameter of the larger pulley. In thousands of cases, however, and wherever there is no other way open, the scheme shown at Fig. 2C with the idler pulley, is very sucessfully used, and the friction between the belt and the pulleys is efficiently controlled by means of the idler pulley.

At Fig. 2D a novel form of belt drive is illustrated which the writer saw some years ago in a large electric power station. This might at first be thought to be applicable only to small motor drives and the like under certain special or freak conditions, but it might be surprising to know that the driver or larger pulley was the fly-wheel of a 500 H.P. steam engine, while the two smaller belt pulleys were on the shafts of two 200 H.P. arc lighting dynamos. The two belts past over the fly-wheel pulley in the maner apparent and a very strong frictional contact was obtained by this novel drive; this peculiar arrangement having been necessitated by the peculiar alinement of the three machines in a certain amount of floor space in this power station.

The method of obtaining reversed direc-

(*Continued on page* 83)

THE REALITIES OF MODERN SCIENCE. An introduction for the general reader. By John Mills. Illustrated, 322 pages. Cloth covers, size 6 x 8 inches. Publisht by the Macmillan Company, New York, 1919.

In this general treatise on the practicabilities of modern science, the author has, we believe, given the layman and student of scientific matters, such as the electron theory, much food for thought. The text has been written in a clear style and in the few places where mathematics appear they are explained so that anyone can understand them.

The author starts with the "Beginnings of Knowledge" and speculates philosophically in an interesting manner just how man first started to use tools, how and why he first made fire, etc. Then he tells of machines of the ancient world; weights and measures; the beginnings of science; the realities of science; the molecular composition of matter; some uses of mathematics; rates of energy; force—mathematically considered; molecular motions and temperature; motions of electrons; interactions of moving electrons, including the hypothesis of the action of magnets, for example—why two magnets attract or repel, etc. The chapter dealing with the explanation of the famous Millikan experiments is certainly commendable and one that tells the story so that the lay reader can grasp it. All in all, the work is highly recommended as a "recreation in scientific literature, but for the student who wants to learn such matters quickly and thoroly, this treatise is too drawn out and not sufficiently illustrated.

THE ELEMENTS OF ASTRONOMY. By Charles A. Young, Ph.D., L.L.D. Profusely illustrated, 464 pages + 42 pages of Uranography, and 4 double page star maps. Cloth covers, leather back. Size 5¼ x 7½ inches. Publisht by Ginn and Company, New York, 1919.

Without a doubt this well-known astronomy test-book by Prof. Young is the best that can be put into the hands of the average student. It should prove to be of inestimable value in all school work, and equally of value to the home-study enthusiast. The illustrations are particularly clear and plentiful as well. One is amazed at the great variety of subjects covered in this one book.

For example, you hardly ever find a small, general treatise on astronomy which says very much about large telescopes—but Young tells you all the essentials of telescopy in clear unmistakable language. He explains why a refractor is superior to a reflector mirror telescope, and why this will probably always remain so.

Every single fact worth knowing on astronomical topics can be found. The reviewer tried to stump it—but the book was there every time with an answer. Young answers such questions as—What is the ecliptic; the earth's interior; gravity; the azimuth and zenith, photography of heavenly bodies; the mountains of the moon; the three librations of the moon in its orbit; is there water or atmosphere on the moon?; sun spots; solar heat constant; sun motors; frequency of solar and lunar eclipses; celestial mechanics; the sun's and moon's tide producing powers; tidal waves; the planets—how to know them; comets—their photography; the spectoscopic study of stars, etc., etc.

PRINCIPLES OF TRANSFORMER DESIGN. By Alfred Still, Professor of Electrical Design, Purdue University. Illustrated with 67 line cuts. 204 pages. Cloth covers. Size 5½ x 8 inches. Publisht by John Wiley & Sons, New York, 1919.

There has been a distinct and noticeable dearth of literature on transformer design for some reason or other, and so this new manual of design by Prof. Still will undoubtedly meet with a ready response. Of course the subject of transformer design cannot be treated without mathematics, but the author has managed to keep most of the text in sufficiently readable form for the non-mathematical reader.

The various types of transformers are discust and examples of design procedure shown. Different methods of core construction receive due attention, as also the insulation and ventilation of transformers, particularly the insulation of high potential transformers. Other sections cover such practical and important topics as: The efficiency and heating of transformers; magnetic leakage in transformers; procedure in transformer design; transformers for special purposes—including those for large currents and low voltages; constant current transformers; auto-transformers, showing the superior efficiency of this type for a certain range of work and its design characteristics; induction regulators of various types for single and polyphase systems.

The Electrical Machinist

(*Continued from page* 82)

tion of the driving shaft in any case is shown at Fig. 2E, and this is quite often done by crossing the belt. In some cases, altho they are not very desirable owing to the power lost in such a drive, belts used under such conditions having been noticed as wide as from six to eight inches. But this practise is to be strongly condemned and the reversal of direction derived in some other manner, such as by means of suitable friction clutches and the general arrangement of the machinery. Proper efficiency of the drive is here curtailed by the tendency of the belt to turn away from the pulley before it completes the proper arc of contact, i. e., 180 degrees of the pulley circumference or more; and also due to the slapping and friction manifested between the two rapidly moving sides of the crost belt.

The speed of motors and line shafting, etc., are usually taken by means of an ordinary watch and *speed indicator* or speed counter, shown at Fig. 2F. Engineers usually make use of an instrument known as the "*tachometer*" the needle of which indicates the speed in revolutions per minute, directly, without using any watch or other attachments. The price of a tachometer is, however, quite high, while the ordinary speed indicator can be purchased for about two dollars or less. There are several other methods of checking up the speed of machinery, especially where large pulleys or slow moving pulleys are in question, where a chalk mark on the pulley or belt can be accurately counted as it rotates or passes by the observer. Using the speed indicator shown, there is provided a friction clutch so that the indicator does not move around the dial to indicate the revolutions of the shaft until the instant that the operator wishes to start his minute or one-half minute as the case may be, as he looks at the second hand of his watch. The rule for determining quite closely (ignoring belt slippage which is always a variable factor), by counting the number of times the chalk mark on a belt past by the observer in a minute, is as follows:

By means of a tape measure or a six-foot rule, the inside length of the belt is first determined, then a white chalk mark is made on the outside of the belt and the machinery started. Say this belt passes by the observer ten times in one minute and if the length of the belt is thirty feet, then the speed of the belt in feet per minute is 10×30 or 300 feet per minute. With a tape measure, or else by computation, the circumference of the pulley the speed of which is to be determined is carefully measured. Suppose that this is 20 feet; accordingly, the speed of this pulley in revolutions per minute (R.P.M.) would be 300 divided by 20 or 15 R.P.M. The circumference of a circle is equal to 3.1416 times the diameter. If the diameter is measured in inches, then to find the circumference in feet, the product should be divided by twelve. Of course this is all very simple on a slide rule if you are accustomed to using one, and if you have much of this work to do you will save much misdirected energy by at once going to your nearest engineers' supply house and buying yourself one, and they are available for one dollar and up. Here's how to make a slide rule for 10 cents—and a very accurate one, too, so that you can multiply and divide decimals to your heart's content. From an engineers' supply house, such as Keuffel and Esser, New York, purchase a sheet of ruled logarithmic paper for a few cents. Cut two

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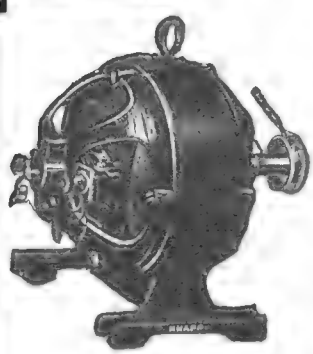

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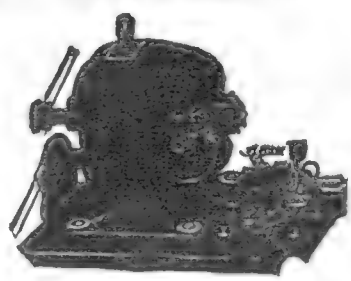

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MEASURING THE LENGTH OF BELTING.

It is often necessary, especially where belting is to be ordered without seeing the installation, to compute the length of belt quite exactly, which is required for certain drives. A method of doing this, used by millwrights and engineers very extensively, is illustrated at the diagram Fig. 3. This method is based on the solution of the hypothenuse of a triangle by geometry; it is apparent that the length of the belt required to connect the two pulleys shown at Fig. 3 is one half the circumference of the large pulley D, plus the half circumference of the small pulley d, plus the two slanting sides at top and bottom or H and H. Where the two pulleys are of the same size, H, or the length of one side, is the distance between the two pulley diameters, and is equal to the length between the pulley centers or L. However, when the pulleys are of different diameters, which is commonly the case, then H forms the hypothenuse of a right angled triangle, the base of which, B, is equal to the distance between pulley centers or L, which quantity is easy to determine. The next quantity which we have to determine or measure is A or the altitude of the triangle. This is equivalent to one-half (D minus d). The length of "H" or the hypothenuse, is then found from the formula $H = \sqrt{B^2 + A^2}$.

It is evident that in any case, all of the dimensions must be either in inches or feet. The length of the belt L in inches or feet, as the case may be, is then found by the following algebric expression: $L = \frac{1}{2}(D_c + d_c) + 2 \times H$. Where D_c and d_c are the respective pulley circumferences.

RELATIVE SPEED OF PULLEYS.

Probably the most important calculation which the young electrical machinist is interested in, in belt drives, is the relative speed of two or more pulleys. Taking two pulleys of respective diameters D and d, the relative speeds are in the same ratio as the one diameter is to the other. In any case, the dimensions must be either in inches or in feet, and all the speeds in a given problem, figured in either revolutions per second or revolutions per minute. Then:

$$D = \frac{s \times d}{S}; \quad d = \frac{D \times S}{s}; \quad s = \frac{D \times S}{d};$$

$$S = \frac{s \times d}{D}$$

The relative speed of two toothed gears are very positive as there is no slippage of pulleys or belts to alter the relation even in the slightest degree, and the speed of the driven gear is exactly proportionate to the ratio of its number of teeth and the number of teeth on the driver. If the driver has 100 teeth and the driven 50 teeth, then the ratio of the small gear to the larger is two to one and the speed of the shaft carrying the small gear will be twice the speed of the shaft carrying the 100 tooth gear. If the 50 tooth gear was made the driver and the 100 tooth gear the driven, it would rotate at one-half the speed of the driver.

(In the next installment we will consider the various forms of gear and chain drives.)

Experiments In Physics

By JOHN J. FURIA, A.M.

(*Continued from page* 41)

drawn out, making the right side longer than the left side, the sound grows fainter and fainter until finally it is practically zero. As the tube is drawn out further, the sound increases to a maximum and then decreases to zero again. At the zero points the sound coming to the ear is practically silence; the waves coming from each side of the tube are opposite in phase and neutralize each other or *interfere*. The above case is one where the sound waves neither come from different sources nor are reflected, the difference in phase is produced on waves from the same source by a change in the size of the path traversed.

INTERFERENCE BY REFLECTION.

Sound waves can also *interfere by reflection*. Attach a thin cork about an inch in diameter to one end of a brass rod three or four feet long. Clamp this rod firmly in the middle as shown in Fig. 5. Slip a piece of glass tubing a little over an inch in inside diameter and three or four feet long over the cork as shown in the figure, and stroke the brass rod longitudinally with a resined cloth. A loud shrill note will be heard. Now scatter some cork dust inside the glass tube and repeat the experiment. The cork dust will be agitated and will form little piles at regular intervals (maximum agitation) alternated by points of rest. This is a case of *interference by reflection*. The sound waves striking the cork at the end of the glass tube are reflected and alternately reinforce and neutralize each other, and the cork dust in the tube is agitated at the reinforcements and remains at rest at the neutral points.

INTERFERENCE OF LIGHT WAVES.

In *Light* interference phenomena are almost innumerable. They are detected in the form of bands (*Interference Bands*). Since light is a wave phenomenon, if we cause two different beams coming from different sources or two parts of one beam coming from the same source to arrive at a point in opposite phases, they *interfere* and an extinction of the light occurs; where they arrive at the same phase reinforcement occurs. The above condition can be brought about in many ways, the simplest being by the reflection of the beam from two surfaces of a thin medium. If a plano-convex lens of slight curvature is placed on a piece of plate glass, and a ray of light strikes it near the point of contact T, the ray will in part go thru the lens and be reflected at C to the eye at E and in part will go thru the air space and be reflected from D to the eye at F (F and E practically coincide because of the very small distance between D and C). See Fig. 6. When the two portions of the ray AB reach the eye at E and F, they will differ in phase by the difference in length between the lines EC and DF, and if this is such as to cause the rays to be in opposite phase, they will interfere and the eye will see alternate bands of brightness and darkness in monochromatic light or alternate bands of colored light in white light. (Since white light is composed of different colored lights, interference will produce darkness of different colors in the different bands, and overlapping brightness of different colors.)

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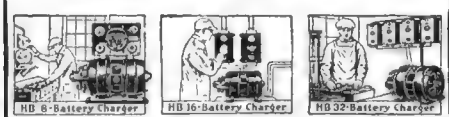

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conditions analogous to the previous experiment, i. e., two pieces of glass separated by a thin wedge of air. Stand the outfit on its wider end (Fig. 7) and place before it a Bunsen flame coming from a burner having a piece of asbestos or filter paper soaked in a solution of common salt at its tip. The flame will have a bright yellow color due to the *sodium* in the table salt, and will for practical purposes give monochromatic light. A series of black and yellow lines will be seen across the plates, the black denoting the neutral light points and the yellow the reinforced points. This experiment must be performed in a fairly dark room. The explanation of the phenomenon is the same as that of the previous experiment.

Most everyone has noticed the colors coming from thin liquid films, perhaps the most common being the film of kerosene on water. The wave is reflected from both the faces of the film and when the reflected beams reach the eye in opposite phases, interference colors are seen.

The classical experiment of Thomas Young performed in 1801 was the first experiment on the *interference of light*. The method is illustrated by Fig. 8. A beam of light is allowed to enter a darkened room, thru a pinhole H. In the path of the beam is a screen of tinfoil having two small holes close together A and B. If either A or B is covered up a bright spot appears on the wall at the point C.

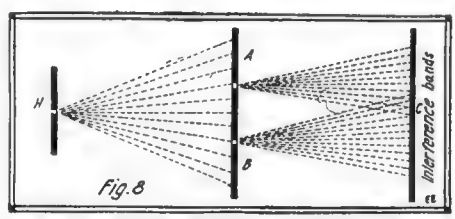

Fig. 8. Young's Experiment Showing the Interference of Light. A Beam of Light Enters a Darkened Room Thru a Pinhole, H. In the Path of the Beam Is a Screen of Tin-Foil Having Two Small Holes, A and B. In It. If Either A or B Is Covered Up, A Bright Spot Remains on the Wall at the Point C; With A and B Open, However, a Round Bright Spot Surrounded by Alternate Dark and Light Circles Is Formed on the Wall. The Light Waves at A and B Here act as Two Waves From Two Different Sources, A and B, and "Interfere" on the Wall or Screen at "C."

However, if both are allowed to remain open a round bright spot surrounded by alternate dark and bright circles is formed on the wall. The waves on reaching A and B act as two waves from two different sources A and B, and *interfere* on the wall.

Obviously, since electric and wireless radiations are waves, interference phenomena occur, but their discussion tho similar is beyond the scope of the paper.

(*To be continued*)

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The Amateur Magician

(*Continued from page* 74)

"Four posts are placed in the table top and thin flexible wires of the same size are fastened to them. These posts may be of wood or may be nickel-plated as desired. The wires fasten into the four glass corners of the glass table, thru which tiny holes have been drilled or other suitable fastening means substituted which fastening means do not have to be very elaborate, as the weight of the arm and hand is quite negligible."

"That is all very fine, Professor," I said, "but how did you know what card I had chosen from the deck?" "My dear man," he continued, "you are a worse magician than I thought you were. Only a month or so ago I told you of the universal pack and here you turn right around and forget it. In addition, you will find that the hand will rap better upon the table, causing a louder sound than on the glass, and sometimes the effect is clearly enhanced if this is done." "Yes, but what made it tap in time with the music when you were sitting at the table?" "Look under the table," he said, "and you will see." A telegraph key in a convenient position revealed there told me the answer—which accounted for the speed of the taps transmitted.

Science in Slang

By EMERSON EASTERLING

(*Continued from page* 63)

and startles the world that light didn't have any specified speed limit and that it didn't always follow the nearest path between two points that school children are forever talking about, but that it sidled up toward Old Sol on its transetheral trip from some speck in space way off in another solar system to our observatories. In the light of Lorentz's and Zeeman's dope, I can't see that Al's line is so startling. Of course he has his place in the sun along with the other *knows*.

"Thomson and Drude tells 'em that the electrons move through atoms of metal like two per cent through a sieve; and from that they began to try and find a place for the electron. We now have it sized up as going to form everything from solid ivory to the paper the Peace Treaty was scribbled down on. They tell us that atoms are built up of electrons, that molecules are built up of atoms, and that that ring on your finger is built up of ——"

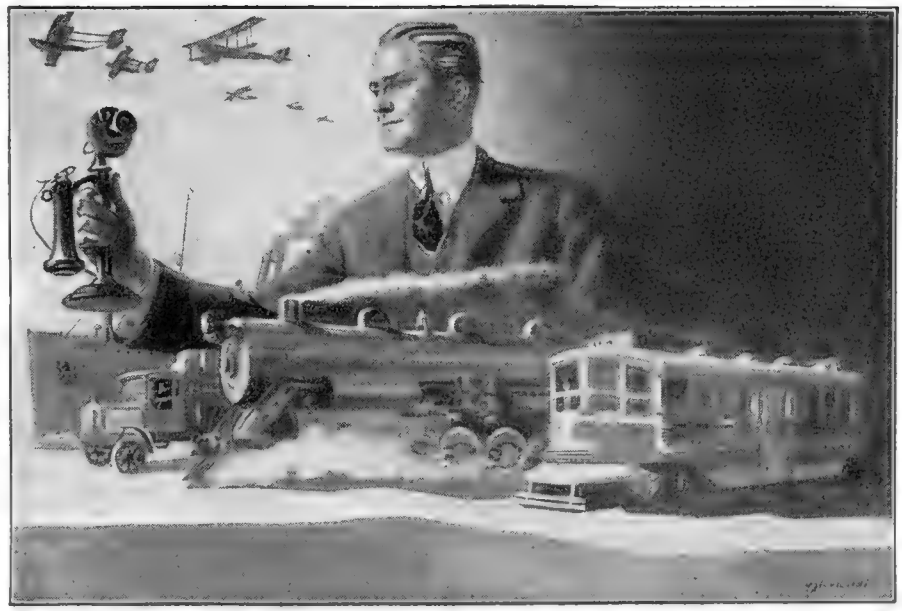
"Brass!" I shouted before he could beat me to it.

"Anyway," he went on, "the electronic theory of the composition of matter bears a striking resemblance to our solar system. The electrons in the atoms resembling our planets in action. In fact it is often referred to as an 'ultra-minute' solar system.

"And how do we know—from this—but that we are to something else as the germs and bacteria are to us—or worse yet, that our Earth is but an electron to some immensely greater constitution; and, on the other hand, that the electron, as we conceive it, an indivisible particle of electricity, is as divisible, could we but fathom it, as is our Earth?

"It's a big world, as the boy from the country said after a trip into an adjoining county, but the universe is so much bigger that the Earth with its world is hardly in it."

"Where is it then, if it isn't in the universe?" I put to him laughingly. But that's neither here nor there.



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The progress of the past, as well as that of the future, is measured by criticism—for criticism exists only where there is faith in ability to improve.

We do not criticise an ox cart or condemn the tallow dip, for the simple reason that they are obsolete. During the reconstruction period through which our country is now passing, if the public does not criticise any public utility or other form of service, it is because there seems little hope for improvement.

The intricate mechanism of telephone service is, under the most favorable conditions, subject to criticism, for the reason that it is the most intimate of all personal services.

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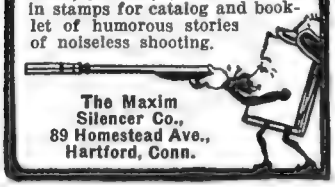

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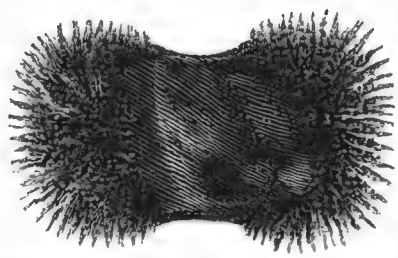

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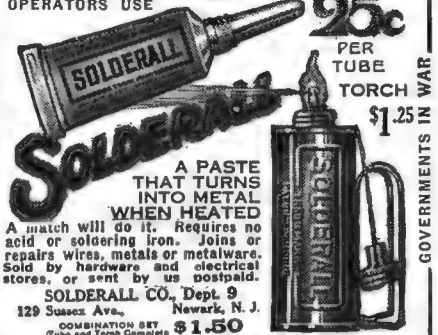

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The "Lodestone" or Natural Magnet

By EUGENE S. TODD

(*Continued from page 27*)

sustain four ounces of iron, but which when capt, according to his method, with finest steel and close fitting, could support twelve ounces. But, he calculates, on the greatest force of a combination, or rather a united nature is seen when two stones, armed with iron caps are so joined by their concurrent or contrary ends, that they mutually attract and raise one another. In this way, a weight of 25 ounces of iron is raised, while either stone uncapt lifted but four ounces.

Now Galileo went far beyond this, since he was able to fashion by his other artifices, small stones of extraordinary power, such as the one he speaks of;—saying it weighed six ounces and uncapt, it could support one ounce only—whereas when suitably capt it could life one hundred fifty ounces or twenty-five times its own weight. He had this stone with him when writing his "Dialogue" of 1632, when he speaks of its being still in his possession. Later, he appears to have presented it to the Grand Duke Ferdinand the second, as we gather from Castelli's "Discorso Sopra la Calamita."

I have seen a small stone only six ounces in weight, capt with iron by the exquisite diligence of Signor Galileo, and presented by him to the most serene Grand Duke, which holds suspended, fifteen pounds of iron, worked into the form of a sepulchre.

This stone is now preserved in the Tribuna de Galileo, in Florence, Italy, and after 300 years, still holds as firmly as ever, its weight of 15 pounds! Is this not remarkable? The weight as just stated, is in the form of a tomb, a form which was probably suggested by the legend of Mahomet's coffin supported in mid-air by lodestones.

Galileo had always great admiration for Gilbert, and for his great work "De Magnete" publisht in 1600. This book, which came into his hands by chance, appealed to him for two reasons, just because its arguments traversed many of the principles of the Aristotelian school, and secondly because it contained a number of original experiments, coupled with philosophical reflections of a far-reaching kind; all of which appealed to his free and daring spirit.

There are, according to Gilbert, many myths and superstitions about lodestones. For example, that a lodestone rubbed with garlic does not attract iron nor also when in the presence of a diamond. There is another assertion that a lodestone placed unawares under the head of a sleeping woman, drives her out of bed if she be an adulteress, or that by its fume and vapor the lodestone is of use to thieves as if the stone were by nature, given to promote thefts, in that it withdraws bolts and opens locks as Serapio insanely imagines.

DISCOVERY OF THE LODESTONE.

In concluding, let me quote from Gilberts "De Magnete" publisht way back in 1600, or over 300 years ago.

"This stone is commonly called *magnet* either after its finder (not Plimp's mythical herdsman, copied from Nicauder, the hobnails of whose shoes and the front of whose staff, were held fast in a magnetic region, while he was pasturing his cattle), or after the district Magnesia in Macedonia, abounding in lodestones; or after the city of Magnesia in Ionia of Asia Minor on the River Meander; hence Lucretius writes—'It is called Heracleus from the city of Heraclea, or after the unconquerable hero Hercules, because of its great strength and its power and dominion over iron, which is known as the *subduer* of all things.' The lodestone is also called Sideritis, as tho one should say *Ferrarius lapis*, meaning iron stone.

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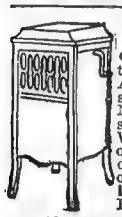

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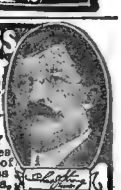

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Some Laboratory!!

By THOMAS REED.

(*Continued from page 45*)

blacked our shoes—mostly on Sunday mornings.

Finally, after years of strategic warfare, I overran the most sacred place of all, the "cold-closet," a brick-partitioned room devoted to the storage of the family jellies and jams. It's a tough fight to oust "preserves," and truth compels me to state that it was won only when my good old mother was no more, and my sisters had married and flown the parental coop. I guess "fight" is the wrong word, anyhow. The process was more like that of the Meek inheriting the earth. "Blessed are the meek," you know. I always used to wonder how they did it.

I wish I had a picture for you of "my shop" as it finally looked, with all its shelves, cabinets, tool-racks and boxes, stuffed and dripping with strange junk, and overlaid with shavings and dust; but alas, I never thought of taking its picture till it had become a thing of the past.

However, to show my interest in the "EXPERIMENTER'S Laboratory Department," I'll send you something much better, some views of the magnificent shop maintained by an amateur of long standing, who began "even as you and I," and by a life time of collection and improvement has arrived at something that'll make your mouth water.

Here are the pictures. What would you give for a "shop" like that? Well, what would I myself, you ask me? Oh, nothing particular, only my right eye, and maybe a leg thrown in as a final inducement, that's all; I never did care much for "shops."

No, indeed, I wouldn't care a hang for a whole well-lighted basement, with a solid concrete floor and white walls, equipt with electric lights and power, with shafting to each machine. I'd yawn and saunter away from all those vises, emery-grinders, taps, dies, reamers, drills and things; and I'd be particularly bored with the outfit of power machine-tools, a list of which is as follows:

Reed lathe, 12 in. swing, 5 ft. bed.
Barnes lathe, 9 in. swing.
Rhodes shaper, 7 in. stroke, 9 in. traverse.
Aurora drill-press, 14 in. swing, boring to ¾ in.
Sensitive drill, speed 1200 R.P.M.
Beckett horizontal power feed milling machine.
Power hacksaw.

No, I would not, and you know it. I may as well be frank. When I view that shop, I feel the way "Sis" does when she sees the Movie star standing with one foot up on the running-board of her pink limousine, drest in her million-dollar fur coat, and her gold hat, and her glove-silk stock—— no, you can't see those on a real nice one, can you. That feeling, my child, is Envy.

Some of this amateur's works are also shown. They include miniature steam engines, dynamos, motors, and almost every kind of electrical apparatus, lathes, clocks, every sort of mechanism that a real "Bug" likes, and likes tenfold, if he has made it *himself*.

This "palace of amateur industry" belongs to Mr. A. M. P. Cowley, of St. Paul, Minn., and if you don't believe me, here is his own likeness to prove it. It was funny how I happened to become acquainted with Mr. Cowley. While I was publishing those clock-articles in the ELECTRICAL EXPERIMENTER a year of two ago, Mr. Cowley got the craze, made himself some clocks, and incidentally made some improvements, about which he wrote me.

Now the letters I get are mostly all from young fellows, whose fearless viewpoint and hearty mode of expression I know very well; and Mr. Cowley's letters showing ex-

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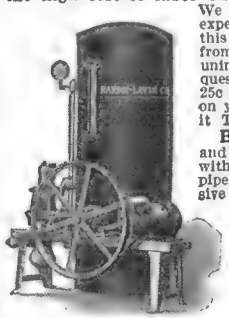

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actly the same characteristics, I naturally put him down as in the 20's.

Some of my fatherly advice must have amused him a lot. He turned out to be over 66, and the "Dean of all the Bugs"—a title which I thought I held myself, until I discovered him. Isn't it striking how an Experimenter never grows old? "Years is nix" with him. You see, Nature is so much older than any of us, and has so many more things up her sleeve than we ever succeed in extracting from it, that a kid with his first junk-built contraption is about the same to her as a wise old engineer like Nikola Tesla or Steinmetz, with a world-altering discovery; so whatever our degree of advancement, we tend to preserve the kid-like attitude as long as we live. Isn't that so?

Mr. Cowley's story, when I got him to tell it, interested me immensely, because it was my own, and yours too—if you're an old fellow. It's the familiar story of the square peg in the round hole—and of the peg retaining some of its squareness even after years of wear. In other words, our inclination for Science persists after almost a lifetime's confinement to business pursuits.

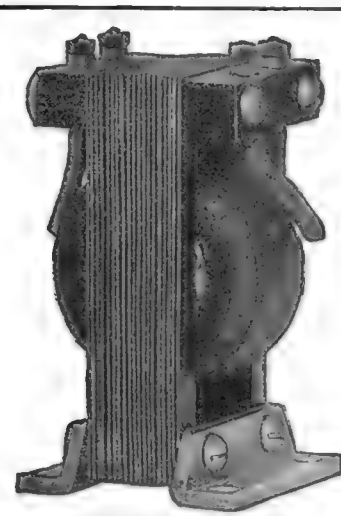
It all comes from the obtuseness of parents in regard to one's youthful ambitions. They are many, and I'll admit most of 'em are temporary, and need to be poohpoohed out of one's system. But when the permanent one comes along, parents should hang up the well-worn pooh-pooh, and take down the new and shining *back-patter*. When they don't, it works like this:

Of course, we began, Mr. Cowley and you and I, by envying the *policeman*. To a three-year-old, viewing the world from behind the front fence, the policeman's life is a peculiarly happy one, W. S. Gilbert to the contrary notwithstanding. The *postman* comes in for some notice, but his lofty rank seems to impose quite a little real work, while the policeman's only labor is to swing his billy when he needs the exercise, and the proudest citizen quails before him. When you're the youngest of the family, you feel that you've done more than your share of the quailing business, and you sure do yearn to be "quailed to" a little.

Then there's the *uniformed fireman;* his lot is almost too *perfect* for contemplation. He not only goes to all the fires, but is paid for doing it. Shakespeare cited "painting the lily" as a case of superfluous inducement, but paying a fireman has it reduced to a wearisome chore—indeed a fine art.

Later on, as the complex world opened out for our approval, we longed to be a *circus clown*. What superb poise, and command of repartee! He was reputed to draw an enormous salary, and to be secretly married to the beautiful bareback-rider, whose frankly exposed limbs set up a new standard of feminine charms. Mother was down on the circus. Money and women! Mercy, what thoughts were these for her innocent offspring to be entertaining?

One by one, we were wafted clear of these pet ambitions and shooed back to the beaten path. But when, a little later still, we were seized by the fever of invention and construction, we were let ramble a little. Parents at first welcomed this novel ambition, because it "kept one off the streets," which even in those guileless times were regarded as the haunts of sin. They found it hard to worry about; but of course, worry they must, and after a few years they began to worry lest we should be drawn by Science away from that serious undertaking known as "earning a living"—Dad gast it! When the kindly caller asked "And what do you want to be, little boy, when you grow up?" and I answered, "An inventor, like Samuel Morse and Alvan Clark," my mother looked "mortified,"—and the caller assumed the expression of one who has unintentionally rattled the family skeleton.



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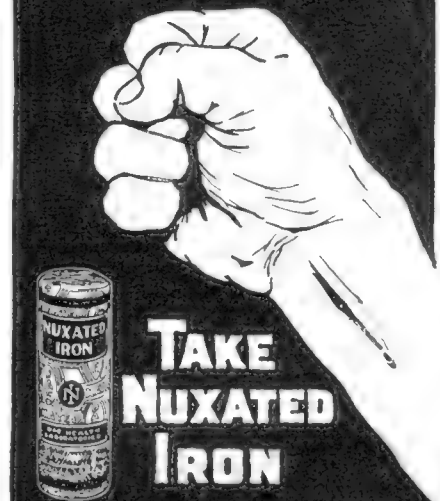

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For their mental picture was not that of the distinguished scientist, sought out for honors and decorations, but of the humble jack-of-all-trades, Sam Jenkins, the village handy-man. Did I want to be like Sam Jenkins, who wore overalls, and rendered his modest bills by word of mouth on the completion of his job—"Wal, would eighty-seven cents be too much?"

Sam could do all kinds of mechanical work—"picked them up," as the saying was, from observation: carpentering, bricklaying, gas-fitting, everything; and could and did do them well.

Regular contractors, however, looked down on him. He had no loft, with "Carpenter & Builder" lettered across the front, nor a store with dirty windows containing a few faucets and washbowls, and the gilt sign, "Plumber." But what a welcome man Sam was, when some household furnishing went on the blink, and the baleful shadow of the upholsterer or the clock-repairer fell "athwart" the family hoard of cash!

Remember how different the times were then. The head-wagging was not over exorbitant incomes earned. The guessing was not that "They'll be sorry some day they didn't save, instead of buying needless things at awful prices." Far, far from such. Prices were reasonable enough. Eggs and butter, those great test staples, were 12 and 15 a throw, respectively; but the problem was where to find the 12 and 15—respectively. Barring Science, each man knew what was the rottenest, worst-paying business in the world: *it was his own.* What you had to sell, people could get along without; but what you had to buy—oh boy! Therefore Sam, with his modest charges and enduring work, was a refuge and defence against the lordly artisans, with ruin in their glance and a mechanic's lien in their inside pocket.

To emulate Sam was *not* our ambition, however, and in citing him as a horrible example, our parents were not quite candid. For all that, we ourselves could never regard his status as an humble one. He had a wonderful shop, furnished with the tools of all trades, which we boys were free to use in a pinch, in our little industries, on condition only that we used them properly, and left them sharp. He taught us ingenious ways of economy; how to use broken and discarded parts—the classic "junk" of Boydom—and was not at all afraid of "spoiling his trade" by such disclosures.

Forgive me for another paragraph on the life of Sam. While the regular artisans were sitting around the winter sawdust-box, settling the country's economics, extending their promissory notes, and laying broad plans against the expected day of business revival, Sam was quietly pervading the community in his overalls, into the pockets of which there trickled a stream of coinage—not a fat stream, but a constant one. The first thing we knew, Sam (still in his overalls) was the owner of an apartment-house, then another, and another. Perhaps, in time, you found your own rent payable to him; and if it was a little late, it was up to Sam to be nice about it, and say that "next week would do." It seemed odd for him to be really owning anything. Or, if your mortgage turned up in his hands, you felt sort of humiliated that your respectable debt had got into such plebeian company, and he had to explain that he "just picked it up in a trade," and it wasn't to make any difference between you and him. And so on, and so on, till the foreign influx flooded us all, and you only caught glimpses of Sam in his limousine, or happened on his name as President of the Board of Trade or something—when you tucked in the frayed edge of your coat sleeve, and comforted yourself thinking of "old times."

What the old folks would have thought of Sam's rise, will never be told. But in his former estate, he lacked prestige; I

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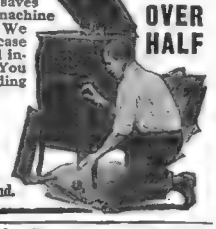

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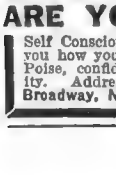

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suppose that was the cause of his lowly esteem. Dear old mother, how indignantly she would have repudiated any such attitude! Sam and his overalls were perfectly respectable, and we were not for one minute to get the idea we were above him. But all the same, we were to do just exactly what father said, and take that position—"position" it was—our uncle offered us in the Bank, where he would give us four dollars every single week—and regular. It was so good of Uncle, and her boy would be known as a *banker,* and wear a white collar, and undoubtedly own the bank in time! Not like Sam at all.

So the result was, we became "bankers," and swept out the dust, and filled the inkwells, and rustled checks over to the Clearing-House like regular "J. P. Morgans"—wearing our white collars and hating the work like sixty—that was all right, however, because work was the "curse of Adam," and not the sort of thing you were expected to enjoy. But halfway down the column of figures, we paused to think out an electrical "hook-up," or the application of a principle of mechanics; and, supper over, we donned the despised overalls, and hammered, filed and sawed, to the detriment of our lily-white banking fingers and oblivion of banking and all that pertained thereto.

We looked forward to the great year of freedom, when we should be 21, and resolved then to change all that. If "position in the community" demanded that we do office-work—why, machine-shops needed bookkeepers as much as banks did, and there we should be dealing with something we liked—might even make some valuable suggestion, and earn promotion for it. But when the great year came, we found ourselves just a little too well fixt at the bank to be willing to drop back and begin at the bottom elsewhere; so there we stayed—for life.

Oh, we're reconciled, in a way. We have our comfortable living, and our daily duties, which are the real source of happiness, after all. But when we see our contemporaries, like Harty and Rogers, Eastman and Ford, and so many others, playing their fascinating game for a living, we regret that our "living" was made a thing apart, with nothing left for Science to provide, except an occasional ride on our wild hobbies—Mr. Cowley making fine machines in that wonderful shop of his, and I, reduced to a drawing-board and typewriter concocting fool yarns like this!

Too much cannot be said about *vocational selection* and *training.* I'll say to parents, in a hissing undertone, "There's nothing more important for *your boy* than to discover what line of work he enjoys, and to give him an opening in it. And mind you, *his enjoyment is the test, not your own gratification* or pride."

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Br'er Rabbit stood on a copper plate
Chewing his cud with an air sedate,
When all of a sudden a blinding glare
Gave Br'er Rabbit a delicate scare.
He said to himself, "What I did expect
Was not to be tickled by 'skin effect,'
But to be stewed in electric broil
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JOHN T. BUSHBY.

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RADIUM IN PLAIN ENGLISH.

By W. E. Ernest, Radium Chemist.

An ore is a mixture of elements. Sometimes it is a chemical mixture, or it may be a mechanical mixture; often it is both. When two or more elements unite to form an entirely different substance (compound), we call this a chemical mixture. It can only be separated back into the constitutional elements by chemical means. A mechanical mixture is simply what the name implies—a mixture of elements or compounds of elements which can be separated by mechanical means. If iron filings are mixed with flowers of sulfur we get a mechanical mixture. We can separate the iron from the sulfur by drawing a magnet through the mixture; but, if we again mix iron filings with sulfur and heat the mixture the iron unites with the sulfur *chemically* to form iron sulfid. Now, iron sulfid is nothing like iron or sulfur either. By going thru a long chemical process we can separate the iron from the sulfur, but it is a difficult job, and, furthermore, when we get the iron back it will not be in the form of filings.

Now, ores are combinations of chemical and mechanical mixtures, as we said before. *Iron ore,* for instance, contains many elements, some in large quantities and often just traces. You find in it sulfur, iron, carbon, manganese, phosphorous, silicon, calcium and oxygen. Iron is the only element that we try to get out of the ore, but some of the others come out as impurities of the iron.

Carnotite is an ore found in Colorado mostly. It contains a whole list of elements just as iron ore does. The elements in it which interest us are all metals—Uranium, Vanadium, Barium, Radium. These elements are separated from the ore by treating (boiling) the ore with certain acids or alkalies.

Barium and Radium are similar in many respects. Radum acts exactly as Barium acts, when they are both treated in the same way. Let us say that Radium does everything that Barium does, but Barium does not do everything that Radium does—i. e., Radium does many things in addition. When the Barium is extracted from the ore (as the chlorid salt) the Radium comes out with it as an impurity of the Barium—not all, but most of the Radium does. The reduction concerns can only get about ninety percent of it out with the best methods of extraction.

Now, the big job is to separate the Radium from the Barium. This would be impossible but for the fact that the Radium chlorid salt is not quite as soluble as the Barium chlorid salt, so they dissolve the Barium chlorid with its Radium impurity in water, boil some of the water off, and let the solution cool. Speaking generally, more salt can be dissolved in hot water than in cold, so that when the solution cools crystals of Barium chlorid separate out. Since the Radium is not as soluble as the Barium you can see that most of the Radium is with the Barium crystals that separate out. Remember, all the Barium did not crystallize out; some of it is still in the cold solution. Well, right here we get rid of some of the Barium. Now, if we repeat this crystallization over and over again, each time getting rid of some Barium, the Radium will become more and more concentrated in a few crystals. Eventually, you will have more Radium than Barium in the crystals. It is possible to keep on crystallizing until only *five* percent of the crystals are Barium and *ninety-five* percent Radium.

When we consider this natural rarity—*about one part of Radium to eight million parts of ore*—and that enormous quantities of acid are used in its extraction, which requires many months work, its high price is quite evident.

Flying In a Vacuum

(*Continued from page 22*)

the exhaust vapor from the engine freezing in the air. This frozen vapor from the engine exhaust hung behind the falling plane in a long stream.

It is truly remarkable to think that in the short course of, we might say ten years, the high altitude flight for airplanes has been raised from a few hundred feet up to nearly 7 miles, at which point the air pressure has changed from 14.7 lbs. per square inch at sea level, to a pressure of but 3 lbs., per square inch at 7 miles. Not only is this a severe strain on the aviator, the blood pressure becoming almost unendurable as the lack of air tends to expand the blood vessels and tissue of the body, which might even burst at so nearly a perfect vacuum as this; but also, in this particular instance, the gasoline tanks on the airplane were crushed in, as the plane descended earthward owing to the rapid increase in atmospheric pressure in so short a time. It is also remarkable that the aviator did not suffer from nose bleeds and ruptured blood vessels so common in persons passing from a lower pressure to a greater pressure in so short a time.

50,000 FEET ASCENT FLIGHT PLANNED.

Prof. David Todd, director of the observatory and professor of astronomy and navigation at Amherst College, announced recently in New York City that he would take part in an aerial expedition shortly in a plane driven by Major Leo Stevens of the United States Air Service to discover new data of astronomical and meteorological importance.

The flight will be made from the field of the United States Air Service at Omaha, Neb., and a new altitude record of 50,000 feet will be attempted. This is 14,000 feet higher than the altitude attained by Major Schroeder, whose 36,020 feet climb is now recognized by the world as a record, according to L. L. Driggs, President of the American Flying Club.

The expedition will be equipt with all the instruments and recording devices necessary to discover any electrical and other disturbances, presence and proportion of gases in the upper air and similar data.

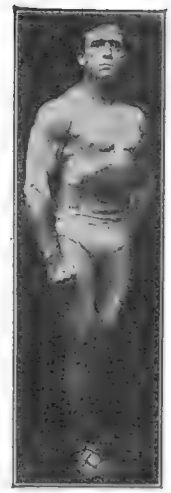
Major Stevens was in New York to consult with Professor Todd over details. It will be the first expedition of its kind.

SOME MECHANICAL CONSIDERATIONS OF HIGH FLYING.

Our front cover illustration as well as the accompanying view, show some of the newest devices for flying at high altitudes, and which the aviator of tomorrow will undoubtedly have to use if he is to reach any such altitudes as 40,000 feet, as contemplated by Major Schroeder for his next attempt.

The accompanying illustration shows among other things, powerful electric heaters for warming the air inside the heavy glass-enclosed cab which the high altitude planes are about to be equipt with. Major Schoeder has rightly remarked after his last flight of 36,020 feet, that now since he has found out how to make the engine function properly on high flights where the air is extremely rarefied and depleted of oxygen, he is going to try and reach a still higher ceiling, possibly 40,000 feet, by means of a glass-enclosed cab, and an extra large supply of oxygen, stored in tanks.

There are also wireless telephone and telegraph sets installed on the plane here shown, and the same instruments which are fitted in the leather helmets can be used to carry on inter-communication between the pilot at the rear, and the observer at the front. The aviator's suits are made extra heavy and fitted with electrically heated



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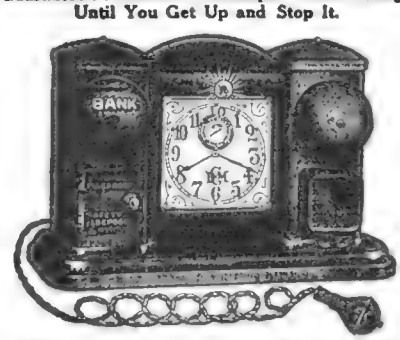

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The Trumpet in the Handkerchief has come to torment us. It is a startler. A small metal trumpet is ingeniously concealed in a handkerchief. On meeting your friends, after chatting awhile, you take out this handkerchief and blow your nose. It's like a sudden clap of thunder! The ladies scream, and your male friends will think they heard the whistle of a steam engine. You can blame the hideous noise to your having a very bad cold, and keep the fun up as long as you like. **Price 10c, 3 for 25 cents, by mail.**

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wires running back and forth thru the cloth in a fire-proof manner, and his helmet as well as his shoes are also electrically heated. Oxygen has usually to be taken when rising above an altitude of 17,000 feet, and a microphone for carrying on inter-communication or wireless telephone conversation with the earth, etc., is built right into the oxygen mouth-piece which can be strapt over the mouth and nose as shown in the accompanying illustration. The electrical energy for operating the wireless set as well as the electrical stoves and electrically heated clothes, corresponding to those worn by Major Schroeder, may be supplied from a small wind-driven dynamo mounted on one of the wing struts as here illustrated, or else from a storage battery.

In this way, all these things will help to make it more comfortable and safer for the aviator, who tomorrow will attempt to rise above the height of 30,000 to 35,000 feet and if perchance he happens to run into such a frigid atmosphere as that encountered by Major Schroeder, where everything becomes quickly covered with ice, including the meter dials on his control panel, etc. Here too electrically heated and motor-driven scrapers or wipers are fitted on the glass windows. These act also, to keep the window clear in case of rain storms, and are at present being installed on many automobiles. The only difference in this type, is that the revolving wiper arm carries a small electric heating coil which serves to prevent the severe cold at these high altitudes, from forming frost on the glass, under any consideration.

If the air pressure is kept at a higher value, approximately that at sea level, or even 2/3 or ½ of sea level, so that seven or eight lbs., pressure is maintained inside the glass enclosed aviator's cab, then the force acting on the glass at say an altitude of 36,000 feet, would tend to force the glass outward; as the airplane descended earthward the air pressure would steadily increase, and the strain on the glass would tend to reverse until it became equalized at sea level once more. However, where the plane might drop as did Major Schroeder's, 5,000 feet in two minutes, the chances are that the glass would break, due to the very sudden and almost instantaneous increase in air pressure, which as aforementioned, caused his gasoline tanks to cave in. This might be obviated by sensitive air pressure regulating valves fitted in the walls of the cab.

PROGRESS SINCE WAR.

Modern inventions unthought of before the war, made not only Major Schroeder's air voyage possible, but also enabled him to return with an accurate scientific record of the flight to substantiate his verbal claims. His machine was equipt with a Moss supercharger and was the same used August 2, 1919, when he broke the world's speed record for high altitude by flying 137 miles an hour at a height of 18,400 feet.

The Moss supercharger is a device composed of a gas turbine and centrifugal air compressor. The turbine derives its power from the red-hot exhaust gases from the Liberty motor. The power generated by the gas turbine is used to operate the centrifugal air compresser at about 22,000 revolutions per minute, and the air so comprest is fed to the carbureter at the same pressure as the air at sea level.

Thus the Liberty motor delivered full 400-horse power, even tho at high altitude.

Major Schroeder was drest heavier than any polar explorer who ever set forth. He literally was wrapt in flexible electric heaters. His flying suit was lined with the fur of Chinese Nuchwang dogs, and between the fur and outer lining, flexible electric heat units, connected by silk-covered wires with the dynamo of the engine, heated the entire suit.

In a like manner his head-gear, gloves and mocassins were heated.

(Continued on page 97)

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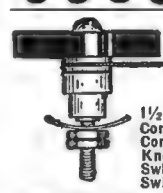

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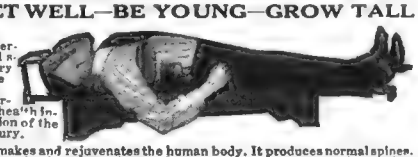

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"How To Market Your Invention"*

By JAY G. HOBSON

THE belief among many people who have originated some new and useful improvement is that securing a patent for their device completes everything that is necessary to win fame, fortune and independence. But success seldom comes so easily.

Obtaining a patent generally constitutes the first and easiest step toward the success of an invention. The development of a practical, commercial, working model of a device is the second important step up the steep and trying hill of progress.

After the working model has proven satisfactory under all tests, we find the greatest obstacle still before us in the form of marketing the invention successfully. I believe it is true that more inventors miss success because of their ignorance of the proper way to market their product than for any other reason.

Lack of sufficient knowledge concerning the buying public and their wants; the manner or form in which they prefer to buy and the best system to reach these buyers, invariably spells failure to the inexperienced person having a good thing but a bad way of letting others know about it.

This ignorance of the selling or marketing end of any invention starts back and shows itself in the preparation of the working model. If an inventor is unfamiliar with commercial requirements, such as the appearance of a device, its size, shape and general contour; the kind of dealers and agents to select for serving the public; the way to pack the article for distribution and the proper advertising and literature to use in acquainting the purchasers with the product for sale; he certainly will not understand how to prepare his invention for the market in a way that will assure success.

For example we will recall the invention of the small metal cap for soft drink bottles which is so common today. A few years ago the inventor of this unique article was walking the streets trying to interest men with money to place it on the market. No one could see its commercial value because the inventor had not fully grasped the commercial requirements himself and incorporated them in his working model. Naturally others, less concerned, could not see what the inventor did not see and that which was not made in the invention. Capital was more interested in the commercial success and just enough in the mechanical side to be sure the ultimate consumer would be satisfied with his purchase.

For two long years this clever device was carried around by its inventor who was hopeful of future success, yet not knowing the secret of his failure up to that time. One day a kindly capitalist, who possessed a little mechanical imagination along with his broad commercial scope, suggested making the cap a little smaller, and more compact, and also outlined a few changes in its appearance which would make it more applicable to those for whom it was intended. At the same time he offered to back the inventor providing he would give him half interest in the patent rights and whatever profits to be made from selling it. This was agreed upon by both and within a short time the improved bottle cap was known the world over. Today the inventor is very opulent from the millions of pennies earned through the enormous sale of this little device.

Then recall the case of the fountain pen. The first one invented was about three times as large as the present popular styles and very inefficient in use. Had the inventor fully grasped the public's desires in a liquid pencil they would have realized the present great success years ago.

This is also true of the present day automobiles. The first horseless wagons of twenty years ago were not all that was desired by the public. But it is possible they and the inventors did not know just what they wanted in a self propelled vehicle.

But today the buying public is more critical and better educated as to what an article should be to give them their money's worth, and it behooves each inventor to educate himself and learn all about the commercial necessities of any new improve-

* Owing to the publication of Mr. Hobson's article this month, no questions and answers are publisht in this number.

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ment before spending money to place it on the market.

Success is not a matter of luck, but a simple fact of knowledge properly applied to whatever plan or business a person desires to promote.

If you would be successful with an invention seek all obtainable knowledge from others about mechanical, commercial and financial plans of operation; absorb what you seek and find, digest it thoroughly and understand it *before* you attempt to become a manufacturer, then apply what you find to your invention which should assure your success under normal conditions providing you have a needed improvement as a foundation to build your success upon.

Copyright, 1920, by Jay G. Hobson.

WHAT DOES THE CLOCK SAY?

Why do we always regard a clock as saying "tick, tock," and not "tick, tick," like a watch? Is there really any distinction between the alternate sounds, or is it a matter of psychology?

The general opinion, it seems, has always been that it was merely a matter of chance whether the "tick" accompanied the left and the "tock" the right beat of the pendulum or vice versa. The first important discovery this authority made was that the "tick" always marks the moment when the pendulum reaches the extreme point of detonation from the perpendicular on its beat to the right, while the reaching of its swing limit to the left is marked by the "tock" in pendulums of all lengths. He found that owing to the fact that the anchor of the escapement mechanism is above the rotating escapement wheel and in the same plane with it, the conditions under which its arms strike the cogs of the wheel are not the same for both arms.

One of the arms of the anchor strikes a cog of the wheel moving upward, in a direction opposed to that of the anchor, while the other arm strikes against the cog while it is moving downward, nearly in the same direction as the anchor. The result of the unequal conditions under which the two arms of the anchor engage the cogs of the escapement wheel is naturally an acoustic difference in the sounds produced by the contact of the parts.

FROM A SWEDISH READER.

Dere Edditor;—

I bane sweede man and from you to me wood like to no some questions answered. Can you 2 me tell why it is that no spark comes akross my spark gap? Today I went by a wireless store and up my mind to be a operator made. So i me bought a spark coil which i seen give two inches of spark.

Tonight when i get him home and a few wires on her, it no work for a tam.

1st, I put one hundred and ten bolts of direct juice on the two binding posts who was nearest together. This is the place where that man said primary was. i next put the tick tick key on these 2 juicy wires what you call akross them. Well that coil she bane in awful hurry to run. She no wait for me to press the key but smoke rite up soon as i turn that switch on. I hear something rip way down in The cellar and the lights all out went.

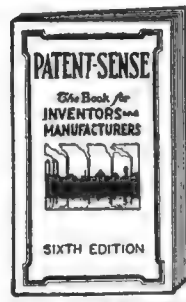
By the lite of a lamp I then notez that the little sprink that make the buzzer noise when the operation by the man was made did not. It was fast together with the other end of buz. i take fourteen inch wrench and make it loose.

I go by auto stable & By 6 dry batteys. The man in stable hook em up 4 me so I get 12 of dem bolts.

I make him buz this time but no spark. I to man say plenty of kick on other end of coil, so i my fingers wet & put em across - - - - - - ? * * ! ! * I yumped up. Yimminey! that Box got least sixty 2 million amperes and I wait from you to hear before I lose other hand.

Yours sparklessly—

"OLE."



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Flying In a Vacuum

(*Continued from page* 94)

Major Schroeder wore an oxygen mask of his own design.

An automatic altitude record is made on an instrument known as the "recording barograph"; the needle of this instrument moving in response to the changes of air pressures, as these changes are caused to act on a diafram or series of diaframs attached to one end of the recording lever. The other end of the lever carries the marking point or pen which draws a curve on a revolving clockwork driven drum, covered with fine ruled paper, the divisions of which correspond to a certain number of feet. In the cover illustration the barograph is shown connected with the outside atmosphere by means of a pipe leading from a Venturi or suction funnel, which are all mounted on the side of the fuselage. The recording barograph on official flights is always sealed before the aviator leaves the ground, and immediately upon the aviator's completion of the flight, the barograph is removed from the machine by officials in charge. The instrument is then carefully checked up or calibrated by experts and the record is then sent to the proper authorities at the Air Service Department, United States Army, or the Bureau of Standards at Washington, D. C. In case of army flights, they are then carefully checked or homologated. Until the record has been finally O. K'd and checked up by the higher authorities, and usually the Bureau of Standards, it is called an *unhomologated record.*

Two or three important things come into mind so far as the design of high altitude airplanes are concerned, and these are as follows: Owing to the much lower sustaining power of the thin air at these high altitude flights, the planes should be much larger for a given weight of machine, and also the propeller should be much longer and wider, or else of greater pitch. It has been proposed to use adjustable pitch propellers for such flying, so that at higher altitudes, the pitch could be increased and a greater thrust or force created in this highly rarefied air.

WHAT DR. CHRISTMAS, AVIATION EXPERT, HAS TO SAY.

Dr. William Whitney Christmas, the well known aviation expert and designer of the high speed "Bullet" strut-less airplane, had the following to say in an interview:

"The probable maximum height or altitude to which an airplane can ascend is governed by several factors, each of which are important in themselves alone, and very important in their relation to one another. Take the plane itself. Its success for altitude depends upon its resistance, weight, pitch and effectiveness of the propeller associated with the uniformity and reliability of the motor power which drives the propeller. It is manifestly evident that when we reach very high altitudes the propeller must be accelerated in its revolutions. This immediately brings to the front the question, How fast can a reciprocating engine, such as the gas motor we have today, revolve without disintegration? We can more or less definitely state that above 3,000 revolutions there is danger of disintegration. We then must find a means of increasing the pitch of the propeller as we ascend because the air gets thiner and thinner as we increase our altitude. This being the case, the propeller must be increased in pitch constantly because it must revolve against this attenuated pressure rapidly and forcibly to get the same results that we do when near the surface of the earth. Of course, with a reciprocating engine having a limit to the number of revolutions, makes such an engine unsuitable to reach the very highest altitudes. We must now seek for a better motor power to accomplish these

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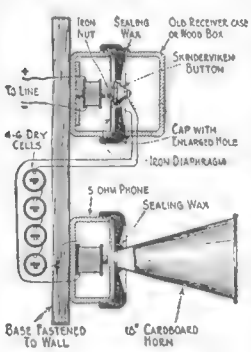

Full directions for connecting up the button for use as a detectophone are given in booklet which is sent with each button.

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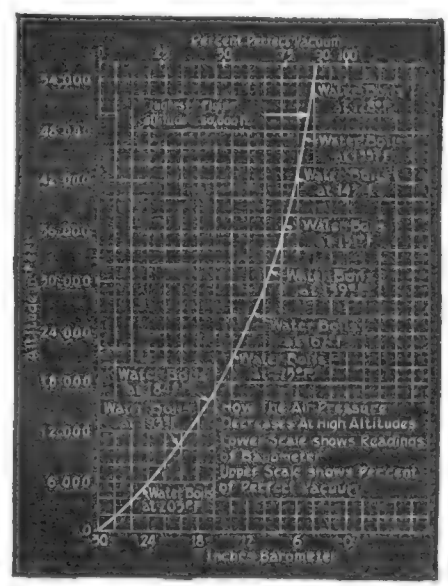
extraordinary results in reaching altitudes. This can be done much more effectively by a turbine engine, either of steam or gasoline, neither of which has yet been developed to such a state of perfection for airplane use that they can be used with confidence. The turbine can be turned up as high as 30,000 or more revolutions a minute, which would be of such tremendous speed that the propeller would not hold together, therefore, it would fly to pieces. However, the turbine can be turned up to the point just short of breaking the propeller. Of course, strictly speaking, no airplane could fly in a vacuum,—that is to say, it could not have a force within itself which would sustain it in a vacuum thru forward motion. Then, strictly speaking from a practical standpoint, there could be no possible reason for wishing an airplane to fly in a vacuum.

"Considering the airplane solely, and discarding the human element, which, after all, is the controlling factor, I would say that it would be possibly to fly an airplane with all the improvements necessary for this feat properly accomplished *to a height of say* 75,000 *feet.* This extreme height is more or less theoretical, but years of practice, application and invention may cause the airplane to reach such a height, but there are many mechanical obstacles to overcome to accomplish such a result, and we cannot hope for immediate success in this direction.

"By actual practical demonstration we find that water boils at a constantly decreasing temperature as we reach varying altitudes. This is due to the fact that the air pressure decreases constantly as we ascend. The laity, as a general rule, do not just understand the phenomena of water boiling. Water boils at 212 degrees at sea level. The reason for this is that this heat is necessary to disturb the equilibrium of the water particles under this pressure of approximately 15 pounds to the square inch, or about 14.7 pounds, to be more accurate. Now as this pressure decreases, it very naturally follows that water is violently displaced thru heat at a much lower temperature. This is an important thing in water-cooled engines, such as used in airplanes, and every natural means must be found for quickly dissipating all extra heat generated by the engine and enough reserve to cause the engine to properly function.

"The human element in altitude flying is even more important than the mechanical apparatus in which the man flies, altho the two cannot be dissociated in altitude work. Man is so peculiarly constituted that he lives at the bottom of this great deep air sea and consequently he lives under great pressure. As he is carried upward gradually and as this altitude constantly increases he begins to exhibit certain physiological phenomena which is detrimental to life function, and if carried to an excess endangers that life principle. One of the peculiar phenomena that we first notice is that the breathing apparatus becomes rapid in its action in its effort to get a sufficient supply of oxygen for proper body function. Another phenomena we have is, as the pressure on the surface of the body decreases there is a tendency for the fluids within the body to escape by the way of the surface and we see the prenomena of skin bleeding and bleeding at the nose, ears and eyes. This is due to the fact that the pressure is not sufficiently great to keep the blood circulation within its proper bounds. Another phenomena which is exhibited in altitude work is dizziness. This, of course, is also a result of decreased air pressure. These various physiological phenomena cause such a state of body and mental unrest that the aviator or observer, or both, constantly decrease in efficiency with a certainty that sooner or later all functions of an intelligent character will more or less cease if the altitude reached is sufficiently great.

"How must we overcome this? It can only be overcome in its entirety in extreme altitudes by inclosing the driver or observer in a hermetically sealed cabin. This cabin must be so mechanically arranged that sea level pressures can be maintained and such temperature, humidity and oxygen supplied as necessary to proper bodily function. There are many mechanical difficulties in the way of a proper accomplishment of this fact. However, these may be overcome to such an extent as to allow an airplane to ascend to such height as at the present moment may seem unattainable. It may be well to say here that the phenomena of boiling water at varying altitudes would have nothing whatsoever to do with the temperature of the body or the temperature of the blood. We have within the brain a point or section which is called the thermogenetic center. This area in the brain is very peculiar in having the automatic faculty of keeping the body temperature in a normal condition. If it were not for this self-regulating temperature government within the brain, it would be impossible for the human being to live under conditions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Altitude in Feet
Water Boils at 212°F
Water Boils at 202°F
How The Air Pressure Decreases At High Altitudes
Lower Scale shows Readings of Barometer
Upper Scale shows Percent of Perfect Vacuum
Inches Barometer

Graphic Curve Showing Per Cent. of Vacuum and Falling Value of Boiling Point of Water at Increasing Altitudes. 50,000 Feet, Is Believed to Be About the Highest Attainable Altitude. The Phenomenom of the Reduced Boiling Point of Water at High Altitudes Has Nothing Whatever To Do With the Body and Blood Temperatures As Dr. Christmas Points Out. Courtesy Charles M. Ripley, of the General Electric Co.

averse to bodily comfort and health. The layman may have an idea that such an altitude could be reached by constant decreasing pressure that the blood itself might have a tendency to boil. This, of course, is a fallacy and could not be thought of except by those who are entirely unacquainted with physiological function.

"As far as we can determine, the atmospheric sea seems to have a depth of about 200 miles. This, of course, is more or less a theoretical conjecture, but it can in a way be called more or less accurate, because the calculation is arrived at thru the law of decreasing pressure and decreasing densities.

"Altitude flying is fascinating, and its practical use will become more and more evident, but its practical limit of height will become more and more evident yet, and it is very reasonable to assume that for any possible commercial use we can confidently believe that 50,000 feet will be the limit for all useful purposes."

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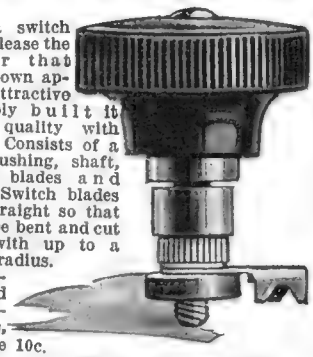

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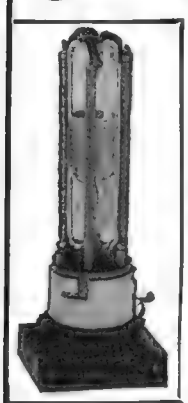

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Long Waves and "Strays" on Rogers Antennae

By LT. COM. A. HOYT TAYLOR, U.S.N.R.F.

(Continued from page 59)

from the current from land wire to ground and by suitably proportioning the two parts of the resistance R, the strays could be balanced out. Such, however, did not prove to be the case and it was recognized that the difficulty was due to the fact that the phase relationship of the current in the sea wire was not the same as for the current in the land wire. The final arrangement for the balance of the land wire against the sea wire is shown in Figure 4, where a phase-adjusting device, L_1 C_1, is put in series with either land wire or sea wire. It is not necessary to have this device in series with each collector. It was usually used in series with the land wire. It will be noted that the ratio of signal to stray on collector number 1, that is, the sea wire, has been further improved by the use of the resistance R_1, which shunts the end of that wire directly to ground. This circuit at once gave very satisfactory results and experiments were immediately continued to determine whether the balance of strays was dependent upon the length and nature of the land and sea wires. It was found that within the limits wherein observations were taken on sea wires, namely from 1,000 to 2,000 feet (305 to 610 m.), the length of the sea wire had but little influence, best results being obtained from 1,500 feet (458 m.) of sea wire. The length of the land wire was found to depend upon the wave length, in general, shorter lengths working better when shorter waves were to be balanced. The *lead-covered cable* was used as a land wire very successfully when the strays were made as bad as possible on the cable by intersecting the sheath, every two hundred feet (61 m.). It is desirable, of course, that the land wire have as bad a ratio as possible. Exceedingly satisfactory balances were obtained thruout the summer of 1918 on all wave lengths between 6,000 and 15,000 meters. No work was done on shorter wave lengths than 6,000 meters. The device was put into the hands of the operators on April 7, 1918, and either this circuit or the following circuit was used at Belmar from that time on for copying all trans-Atlantic signals. Encouraged by the success of this method of balancing two wires, attention was again given to the rectangle, since the rectangle showed just as bad a ratio of signal to stray as the land wire and should have sufficiently similar directivity. The rectangle was therefore substituted for the land wire. The resistance R is sufficiently high to give the rectangle a very high decrement. The tuning is exceedingly flat. No marked success was obtained until the circuit shown in Figure 5 was adopted, that is, until the sea wire was shunted to earth thru a small resistance R_1. The exact functioning of this resistance is not understood, but its presence, especially in the balancing of a rectangle against a sea wire, is of the utmost importance. Figure 6 shows the design of a panel to be placed to the left of a standard Navy long wave receiver, this panel providing the necessary terminals for sea wire and either land wire or rectangle. It also contains the phase-adjusting device in series with the rectangle or land wire, the balance resistance, and the shunt to earth on the sea wire terminal. This circuit, Figure 5, is dependent also for its success upon the proper choice of the dimensions of the rectangle, since it is necessary to have a comparatively high resistance in series with it at all times. The rectangle must, therefore, be designed to have adequate collecting power. Naturally

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this depends upon the wave length. For 6,000 meters a rectangle 30 feet (9.2 m.) by 77 feet (23.5 m.) with 12 turns of number 10 wire spaced .6 inches (15.2 cm.), was found satisfactory. For waves from 10,000 to 15,000 meters, a rectangle of the same dimensions but with double the number of turns was found best. The setting of the phase-adjusting condenser depends slightly on the depth of the water over a sea wire. As the tide came in it was found necessary to advance the phase slightly in the ground wire or rectangle, as the case might be.

METHODS OF ADJUSTING BALANCED SYSTEMS.

The method of adjusting the balanced system is described as follows (reference Figures 4 or 5):

(a) The slider of the resistance R is pushed to the right until there is little or no resistance between the slider and collector number 1. The primary of the receiver is adjusted by variation of the inductance L and the capacity C until it is tuned to the incoming signal. The resistance R_1 is adjusted to the lowest value which is consistent with good audibility of signal. The secondary L_2 is adjusted in the usual manner as are also the amplifiers.

(b) The slider of the resistance R is pushed to the left so that little or no resistance lies between the capacity C and the primary. Without changing the primary adjustment, the loading coil L_1 and the capacity C_1 are adjusted so that the same signal is received from collector number 2.

(c) The slider of the resistance R is then moved back and forth until the best readability of signals is obtained, the normal position being nearer the end of collector number 1 than to the capacity C_1. In other words, the larger part of the resistance R will normally be in series with that collector which produces the worst strays.

(d) The condenser C_1 is now varied so as to shift the phase slightly in collector number 2. This adjustment is fairly broad, as on account of the resistance R, the tuning in the circuit involving collector number 2 is extremely broad, in fact the circuit is almost, if not quite, aperiodic. After a few adjustments have been made, the balance of the circuit is extremely simple, reminding one forcibly of the method of balancing employed in the bridge method for comparison of inductance at audio frequencies, where variable resistances and one variable inductance are used and the other unknown inductance is fixt. The difficulty of balance is of exactly the same order, which means that after a very little experience, it is not difficult at all. In fact, after one or two days' training, this system was put into the hands of operators who had had comparatively little experience, men who had been thru the Naval Radio School at Harvard University and whose only practical experience was that which had been acquired in the course of duty at the Belmar station. From time to time slight corrections in the balance may be advisable, as the character of the strays changes. These corrections are, however, mostly in the phase-adjusting condenser C_1, and were thought to be due largely to the influence of the tide in shifting the phase of the signal in the sea wire.

CHARACTER OF STRAYS.

The behavior of the balanced system is such as to lead to the conclusion that strays are very complex. Certain very sharp and violent strays were soon recognized, after experience with this set, to be of comparatively local origin, traceable to some storm within a radius of about one hundred miles (160 km.). It would frequently happen that it was possible to obtain trans-Atlantic copy when there were violent storms in the immediate vicinity of the station.

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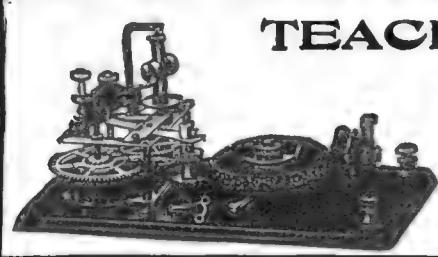

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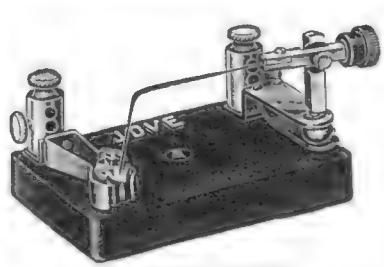

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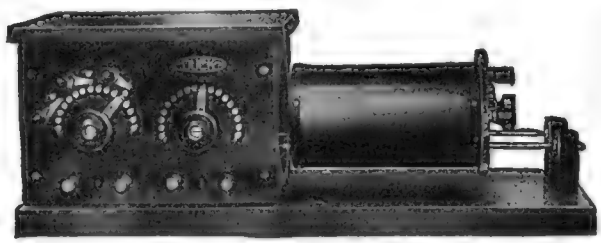

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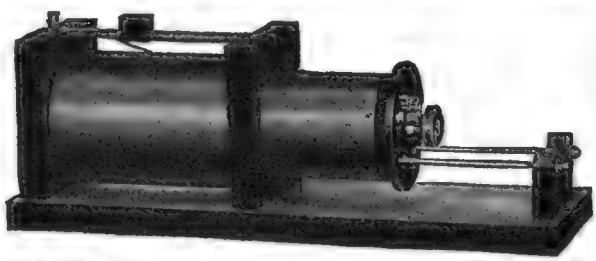

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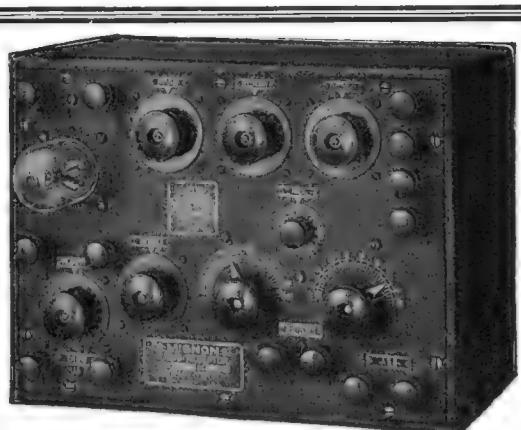

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A Wartime Radio Detective

By PIERRE H. BOUCHERON.

(*Continued from page* 55)

and prepared to put up a stiff fight with dangerous enemy criminals. Arriving at the suspected house I noted with satisfaction a shingle on a first floor window bearing the caption, "Dr. Heinrich Schmidt." Ah, I thought, this is meat! A maid admitted me and I asked to see the doctor. I had visions of meeting a German scientist peering at me thru miopic glasses whose business it was to help the fatherland along in his own particular chosen way. Incidentally I kept a sharp watch for any possible disappearing traps with which the touch of a button might send me hurtling thru space into a dungeon near the coal bin. The doctor finally came in, licking his chops, from which I inferred he had been at his meal. I had received a mental shock, for the doctor seemed nothing but a harmless old soul possibly eighty years old. However, I was not to be so easily hoodwinked. In my best stentorian voice I asked for a word in private. The doctor led me into his office where I explained to him briefly my mission, and that I wisht to make a complete search of the house. The doctor registered surprise, then amusement, after which he laughed heartily, and handing me a cigar said he would be *pleased* to have me investigate the premises.

I went thru the upper floors of the house without noting anything suspicious and finally came to his study on the second floor. Upon glancing around the room my eyes immediately spotted something which made my hair bristle up as it were, for there in one corner of the room was a *genuine static maker*—also known as a Wimshurst static machine. At this the doctor seemed as amused as I was surprised. I looked the machine over very carefully but could find no possible connection to a secret antenna or to either a gas or water pipe ground.

The doctor explained that he had had the machine twenty years, and had used it for the treatment of nervous diseases many years ago, and at a time when electricity in any form was considered to be the long-sought-for panacea or curer-of-all-ills. He explained also that he had not used the machine in years but that he could, however, account for the report in the following manner. About a week previous a curious patient had wanted to know what the machine was for and how it worked, at which the doctor had obligingly operated it by turning the rotating discs several times. This, of course, produced electric discharges between the two metallic discharge balls, and the noise could easily be heard by passersby on the street. It turned out later that it was during this instance that an alert "Boy Scout," with a hazy idea of the elementary principles of radio, happened to pass the house, heard the machine and due to its similarity in sound to so-called *static* had decided that it was for the express purpose of creating *static interference*. So much for fizzle number one.

THE TELEPHONE LINE "SECRET" RADIO STATION.

Reports of this type were probably the most frequent ones received at headquarters. In these interesting little comedies persons in and about New York City, Philadelphia, Boston and other large cities would report that they had heard secret wire messages being transmitted over *their* telephone lines; not only that, but they were *certain* it was the work of German

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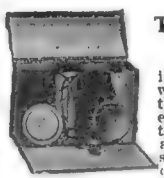

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spies in the immediate neighborhood. In many cases some of the informants claimed they had telegraphic as well as radio experience and could easily distinguish *some* of the words. In order to substantiate these naive statements, they would forward copies and extracts of the messages with such suspicion-arousing words as "troops," "transports," "submarine," etc.

Reports of this nature were childish, to say the least, and one does not have to be well-versed in radio or in the handling of codes to know that anyone attempting to send such messages over a telephone line would not resort to such crude methods, but would use code and cipher, which might take months of constant work to decipher, and in some cases might never be fully understood.

However, I will mention one of the most interesting cases of these so-called "telephone-line radio stations." This was reported by an elderly spinster living near Islip, L. I. She lived in a rather secluded section of the country surrounded by a thickly wooded part. She had been hearing these signals for a period of several weeks and had called the attention of the telephone authorities to it, and altho the telephone company had investigated the matter in order to explain the probable origin of the signals, nothing had been definitely obtained and the signals were still being heard, usually at stated hours of the evening.

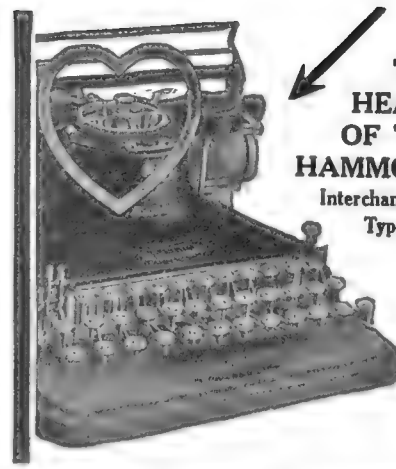
This worthy lady based her assurance that the signals were *radio* on account of the fact that she had made several trips across the Atlantic on large passenger vessels, and that she had visited the Marconi station on board, where the sending and receiving of messages had been *fully explained* to her by the operator. She was certain, therefore, and as she explained in her report, that "she knew what she was talking about." Also, she believed that her particular location would be an excellent spot for an *enemy radio station*, as very little traffic and few persons ever came near her home.

At the same time she reported that one of her gardeners who had been employed by her for the past few weeks seemed to act strangely at times, and there were many occasions when he could not be located. Strangely enough, he would usually make his appearance after she had heard the signals over the 'phone.

Investigation disclosed the fact that this "great radio mystery" was nothing more than a swinging high-tension power line in close proximity to the lady's telephone wire. This information was obtained after several days of hard work in testing many wires in the vicinity and in collaboration with the telephone officials. Numerous tests were made on various lines in the neighborhood, each one being isolated and separately tested. In this way the fault was found. The signals were very strong on *rainy days*, which was due to the electrical leakage between the power line and the telephone wires. The swinging, of course, was not of constant amplitude but was controlled by the degree of wind pressures at spasmodic or intermittent moments and in such a peculiar manner that the induction or transfer of energy produced impulses on the telephone wires of *short* and *long duration*, greatly resembling dots and dashes. In fact, upon hearing them, even an experienced telegrapher would have doubts as to whether or not they were human made.

A REAL CASE AT LAST.

It is needless to say that we sometimes worked for many weeks before a real, honest-to-goodness case presented itself. The case of the *Grist Mill*, however, turned out to be the real thing altho at first it certainly did not look very promising. The



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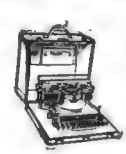

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report came to us from a remote and complicated channel. In fact, I never did learn its real origin. No doubt it was the work of a closely veiled agency, which even we were not permitted to know about.

On a certain stormy March day I was dispatched to L..... in Ulster County, N. Y. Arriving there I met two plain clothes men attached to the New York state constabulary who had, by prearrangement, been sent to assist me in the sleuthing end of the case. Briefly the case was just this:

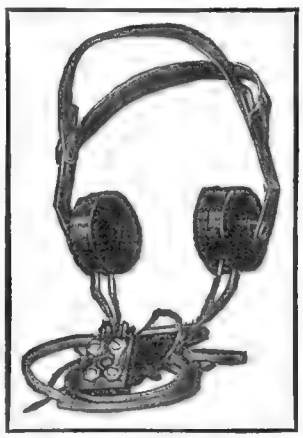
The armature of a large motor-generator had been seen transported from the railroad station to a grist mill a considerable distance away. Since the mill operated by water power a certain individual had, naturally enough, wondered to what use such a large piece of electrical apparatus could be put to in so remote a section of the country. It was, therefore, my particular duty to investigate the locality, "hang around" and ascertain just what the activities of the grist mill were, as it was inferred *radio* might have something to do with the case.

My two sleuthing friends and I accordingly hired a rig from the only stable L..... could boast of, and started out for the grist mill which was nearly thirty miles away. Under the guise of New York state watershed guards we stopt at a farm not far from the grist mill. Despite several days of careful investigating and a close study of external conditions connected with the mill we failed to note anything unusual or even suspicious, and my two friends were strongly in favor of dropping the case. However, my orders distinctly read to "stick around" regardless of time and not to overlook anything, even tho it began to look as if life at this particular grist mill was confined to nothing more interesting than an occasional farmer dropping off a few bags of corn or so and returning at nightfall for it.

After two weeks of "watchful waiting," I too decided the case to be another "false alarm" and was preparing to report my belief; in fact, had actually sat down to do so, when gazing absently out of the window of the shack we were stopping at I noticed on a distant hill a familiar telephone and telegraph pole on which were hung several wires. Of course there was nothing unusual about this, but I began to wonder just where this line led to, for I had not even seen or heard of a telephone in this vicinity, nor did the farmer know of one. Now I have always been interested in telephone and telegraph work; in fact, when I was a youngster, just beginning to learn telegraphy at the local railroad depot, I used to climb telegraph poles, tap various lines thru a portable set to ground and thereby have a "load of fun" with train dispatchers and towermen. I was finally caught in the act and shall never forget the experience. But that, as Mr. Kipling says, is another story.

Upon seeing this particular line, so far removed from its usual surroundings, I decided to look it up. I accordingly reached the spot of one of the poles where I saw there were exactly two wires stretched on the one crosstree carrying the usual glass insulators. Since the line was nowhere near the main road, curiosity led me to follow it which I did for a distance of about 1,000 yards. Imagine my surprise when upon reaching this spot the string of poles *terminated,* and so did the wires! The four wires simply were fastened to four glass insulators and stopt there. I concluded that the line was probably a discarded one and was thinking seriously of climbing the pole and testing each wire when I first decided to see how far the line went in the other direction. Accordingly I walked a distance of less than

MURDOCK No. 55



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a quarter of a mile where I was again surprised to note once more the end of the poles! This, however, was at a place covered by a considerable number of trees but imagine my amazement when by close scrutiny I noticed that the two telegraph wires reached a "common joint" to another well insulated heavier wire leading from the last pole thru the trees in a carefully insulated manner. There was only one answer to this unusual telegraph wire arrangement—it was a disguised *wireless antenna!* I could hardly contain myself with excitement, as I pusht my way thru the trees and heavy underbrush keeping my eye on what I now felt sure was a long wave listening-in station. After going down hill for a short space I began to hear the familiar waterfall and the overshot wheel of the grist mill, and finally I came to a slight clearing and noticed with satisfaction that the wire led, in a cleverly disguised manner, thru one side of the mill. I was now fully convinced that the place was equipt with at least a long distance receiving outfit. However, nothing could be done just then without arousing suspicion, as it was still daylight. I accordingly returned to the farmhouse and explained my find to my two companions. These gentlemen were for pulling out all artillery and making a "grand sweep" upon the mill; a suggestion which I quickly tabooed.

My plan was to come back at night, try to force our way into the mill, which I had previously noted could be easily done, and thus see what was actually "going on." We carried out this plan and found no trouble in slipping in at a point near the overshot wheel, and owing to the terrific racket it made, what noise we did make could not be heard. The three of us kept close together and prepared to make a stealthy but systematic search of the entire building. It took us exactly one hour to do this, after which we had heard absolutely no strange sound nor seen any gleam of light which might suggest the presence of anyone "listening-in." The place, to all appearances, was absolutely deserted at this hour of the night. Remembering the side upon which the lead-in was inserted, we decided to look again for a possible unexplored section of the building. We therefore climbed to the very loft and for fifteen minutes or so carefully and quietly listened for any unusual noise. After a short time our eyes had become accustomed to the darkness, and it was then that one of my companions touched my side and pointed my face towards what I saw to be a tiny gleam of light. We carefully moved in this direction and reaching it I applied my eye to the crack. My hair literally stood on its ends as I looked and saw a young man, telephone receivers on his ears and in the act of "copying." On the table and directly in front of him was what appeared to be a complete receiving set with several vacuum tubes burning brightly. What little noise we had made, of course, could not have been heard by the listener, owing to the telephone receivers clampt tightly on his ears, a fact which I communicated to the two men close to me.

Our flashlights disclosed a door which being unlocked enabled us to walk right into the room, where with drawn revolvers we suddenly faced the young man. He never batted an eye, and in fact hardly seemed surprised, taking the whole proceedings as a matter of course and part of the day's work. While my two companions were attending to the young man, I looked at what the operator had been copying and saw it was coded words similar to those which were frequently transmitted during the war by European high-powered sta-

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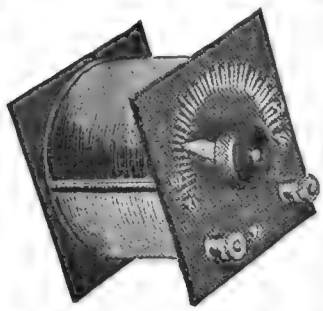

The rotary variable condenser is a necessity for all experimental wireless work and one or two of them are to be found in almost any wireless station. The two most popular types are the 43 plate and 21 plate with capacities of .001 mfd. and .0005 mfd., respectively. The large size has 21 rotary aluminum plates and 22 stationary aluminum plates. The small size has 10 rotary and 11 stationary plates. The ordinary rotary variable condenser is mounted in a cheap round metal case with a cheap composition top and coarse scale. Its plates are 0.15" thick and the shaft is 3/16" in diameter.
The "Tewno" Rotary Variable Condenser has two genuine "Formica" ends, a clear glass case, a ¼" shaft and plates .024" thick of a special grade of aluminum. However, the biggest feature in favor of our condenser is the form of end-piece used. It is square, facing the operator. It is not necessary to look over one's hand to see the scale, as was the case in the old upright type of condenser. The scales on these instruments are calibrated to 2½ degrees.
We recommend our 43 plate condenser for primary and secondary tuning on sets of fair range and for use in oscillating circuits. Our 21 plate condenser is well adapted to short wave tuning for use in small wave meters and a great variety of work calling for a small variable capacity.
Do not be fooled by an instrument that is "just as good." These are to date the best condensers on the amateur market.

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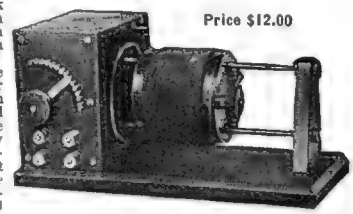

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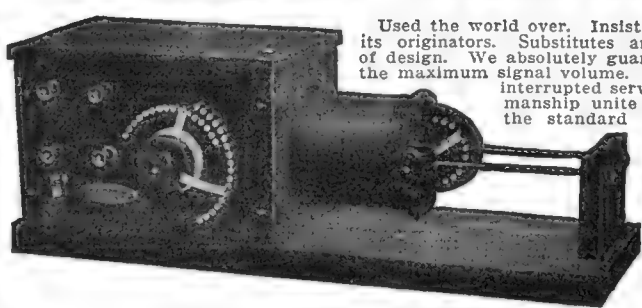

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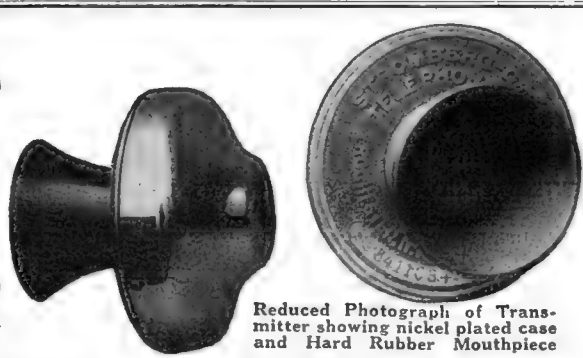

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tions. Upon listening-in myself I heard the familiar spark of "POZ" beginning its usual sing song "groupen, etc."

Upon questioning the operator we were unable to secure any information whatever, so we took him over to the farmhouse for the rest of the night. Next day upon looking over the grist mill we found an explanation for the use of the mysterious armature. In one part of the building a large motor-generator was in the process of being erected to be operated by water power. A large transformer and a considerable number of Telefunken radio telegraph parts were found about the place preparatory, no doubt, to the erection of a transmitting station probably capable of communicating with submarines at sea thru the use of the excellent telegraph line antenna possest of unusually long wavelength.

The details of the rest of this experience cannot be disclosed here, but suffice it to say that no "mistake" had been made in this particular round-up.

The next three cases of this series will unravel the "Singer Building Signaling Mystery," the "Phantoplex Circuit Paradox" and the "Enigmatic Shipment of 'Medical' Supplies to Mexico."

Newton's Less Popular Laws

By PROF. JAMES S. STEVENS.

(*Continued from page 24*)

so inclined. The mere bumping never hurts us; *it is the fact that the wall bumps back.*

Whatever changes may be made in Newton's great laws their value as underlying principles in physics will never be questioned. It was said of Newton that God displayed him as we display an ape, meaning that he was of such an unusual order of intelligence that he stood out conspicuously from the rest of humanity. Alexander Pope said:

"Nature and Nature's laws lay hid in night;
God said, Let Newton be! and all was light."

A newspaper has recently amended this,

"We thought that space was straight and Euclid true:
God said, Let Einstein be! and all was askew."

Those who are fearful that they will have to learn their physics over again on account of Einstein's discoveries need not give themselves very much concern. It will be many years in the future before Newton's laws will cease to be fundamental in our physical theories. Any modifications in these laws will be referred to at the bottom of the page by means of an asterisk, and the statement will be made that under certain unusual conditions in space, *which do not affect the dwellers on the earth in the slightest degree*, Newton's laws are subject to certain modifications.

$50.00 In Prizes

See Page 38

A One Tube Radio-Telephone Transmitter

By PIERRE H. BOUCHERON.

(*Continued from page* 57)

tap is made in a like manner but this time slightly passing the point of the first tap. This procedure is followed for the remainder of the forty-eight turns so that the final result will produce a diagonal row of taps in respect to the length of the coil. This slight spacing of each tap is necessary in order to avoid "bunching" connections and consequently a much neater and more workman-like appearance is the result. After this procedure, each twisted loop should be carefully soldered in order to make it a permanent and sturdy tap.

Connection to any of the above fifty turns may then effectively be accomplisht by making use of three universal clips, similar to the one shown in Fig. 2, and which may be purchased at slight cost. The connecting wires, of course, leading from the various instruments are soldered to the clip in the specially provided slot. The clips may then form a variable means of contact at A, B and C of Fig 1 and these as well as the two variable condensers having a maximum capacity of .0005, are varied accordingly until the proper value of inductance and capacity is obtained to secure best results. The grid-to-transformer resistance of 10,000 ohms will probably also have to be either decreased or increased until an effective grid resistance has been secured.

See Fig. 2 for a general idea of the scheme of construction and method of connecting. All tapping connections to and from coil as well as all other permanent connections of the circuit should be properly soldered. This precaution is very necessary in order to insure perfect contact, for in a system of this kind, the radiated energy is very small, possibly in the neighborhood of 0.2 ampere and it would not do to waste any of this small energy thru loose or "grinding" connections.

The telephone receivers should have an impedance of 2,000 ohms or more should the plate voltage be over 250 volts, as otherwise receivers of lower impedance might heat up and possibly burn out with higher plate voltages, for it will be noted by referring to the circuit of Fig. 1 that these receivers are directly in series with the high potential battery. The grid leak in this instance should be approximately 10,000 ohms and may be constructed by drawing a pencil line on a small piece of cardboard and connecting the two extreme ends of the carbon line with two battery binding posts.

"B" BATTERY SUGGESTIONS.

The ideal way, of course, to secure the high plate potential of two hundred or more volts is by means of a small motor-generator set, but since these are not within reach of many amateurs and cost at least $75.00, the next best thing to do is to employ a large number of small dry cells of the flash-light battery type. Nine units of the twenty-two-volt type will furnish approximately two hundred volts, which will be quite sufficient to carry out this experiment successfully, altho if possible, a higher voltage is recommended should the amateur be in a position to purchase additional cells.

The two regular dry cells, which furnish approximately three volts, when joined, are connected in series with the primary of the telephone repeater coil and the telephone transmitter. The vacuum tube and the two variable condensers are connected in the manner shown in Fig. 1.

The antenna used in this case should not have a natural period over 150 meters wave length; in other words, it should not be much over 50 ft. in length and should preferably be of the two-wire type.

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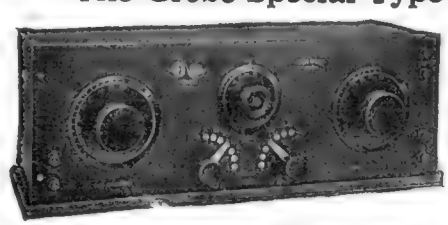

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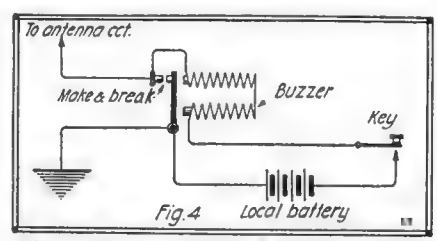
If the radio experimenter has a radio friend who lives a short distance away he can then arrange to have him "listen-in" until the most desirable results are secured, either when using the circuit as a radiophone or as a radio-telegraph transmitter. After this, further experimenting will probably increase the range of the set until five miles or more are covered. *Right here it may be said that a similar circuit employing a 400-volt plate potential has successfully covered a distance of twenty-five miles.*

When it is desired to employ this circuit for radio-telegraph transmission by means of *undampt waves*, a key may be placed directly in series with the antenna circuit, in this case preferably in the ground lead as shown in Fig. 1. The key can be one of the regular telegraph keys having a circuit closing switch, so that the circuit may be closed when it is desired to use the radiophone. With this arrangement, of course, the receiving station must be prepared to receive undampt signals; that is to say, be equipt with a short wave regenerative or oscillating circuit; or else a Poulsen tikker may be used.

On the other hand, if it is desired to telegraph by means of dampt waves, the emitted energy must be interrupted by means of a so-called "chopper." A chopper circuit suitable for this purpose may be secured by means of the arrangement shown in Fig. 4. In this case a high frequency buzzer is operated by means of a local key and battery and the contact, or make and break points of the buzzer, are connected in series with the antenna circuit. If the vibrator of the buzzer is adjusted to make and break 500 times or more per second it



"Chopper" Circuit for Breaking Up Undampt Oscillations in Antenna Circuit so as to Be Audible on Crystal Detector

is evident that 500 interruptions will occur in the continuous antenna circuit, and thus 500 groups of dampt waves will be radiated. With this arrangement the receiving station will receive the signals quite effectively with an ordinary crystal detector circuit.

RECEIVING-TRANSMITTING CIRCUIT.

In Fig. 5 we have a circuit capable of transmitting as well as receiving undampt waves. This circuit may be found quite useful because it employs a regular loose coupler receiving tuner and appropriate condensers. This permits a wide range for either sending or receiving; that is to say, undampt waves may be sent on as low as 100 meters, (providing, of course, that a small amateur antenna is being employed) and up to 1,000 meters or more. As will be noted, the circuit is an oscillating one. When it is desired to transmit on, say, 200 meters, both the primary and secondary of the loose coupler are tuned to that wave, the value of variable condenser C-1 is properly reduced and, providing the bulb is oscillating, undampt waves may be radiated into proper signals controlled by the regular telegraph key, which in this case is also connected directly in the ground circuit. When it is desired to receive, the circuit-closing switch of the key is closed and the circuit may then be adjusted for reception.

MODULATION.

The average amateur no doubt understands the meaning of modulation as employed in radio-phone circuits. Briefly, it means that the amplitudes of emitted or antenna oscillations are varied, up and down,

at frequencies corresponding to the intonations of the human voice. In this respect great care must be exercised in building necessary radiophone apparatus so that modulation may be effected *without distortion of the voice.*

In the circuit previously mentioned, that is, Fig. 1, modulation is obtained thru grid current control. There are, however, several other ways in which modulation may be obtained; in fact, the regular carbon grain transmitter mentioned here may be connected at many places of an oscillating vacuum tube circuit with more or less satisfactory results. For this reason the amateur should experiment in an attempt to discover the best place for the transmitter consistent with his own particular hook-up. That is to say, he should try placing it in the filament circuit, in series with the grid circuit, as well as directly in the antenna circuit. Some methods are, however, peculiarly adapted to one, bulb circuits. Fig. 6 shows a simple hook-up where the telephone transmitter is placed in the antenna circuit and modulation accomplisht by varying the amplitude of the emitted vacuum tube energy.

SUITABLE VACUUM TUBES.

Altho large vacuum tubes, also called oscillions, pliotrons, etc., are coming more and more into use for radio-phone and radio-telegraph work, the smaller and more readily obtainable receiving tubes may be employed by the amateur for any of these experiments. The Marconi V. T. No. 2 has an output of about five watts at a filament voltage of 4.3 volts, and will probably stand a maximum plate voltage of 550 volts. The Western Electric V. T. No. 2 also has an output of about five watts at a filament voltage of 7 volts and a plate voltage of about 350 volts. These figures are mentioned in order to give the amateur an approximate working idea.

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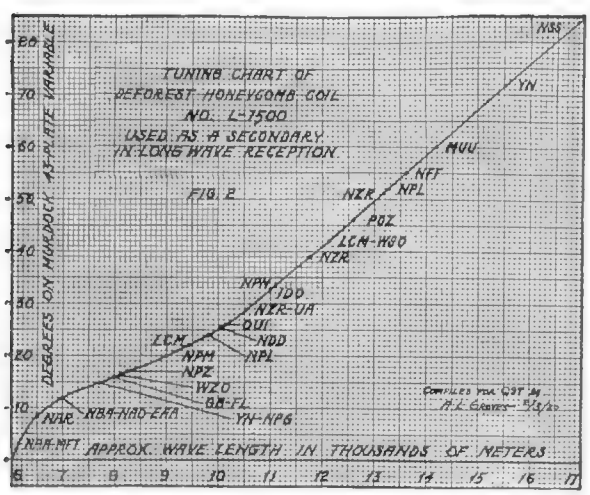

(Illustration by Courtesy of Q. S. T.)
A wave-length chart showing DeForest "Honey Comb" Coil reception by an Amateur unknown to us. He has written an article on the value of these Coils. Read it in the March number of Q. S. T.

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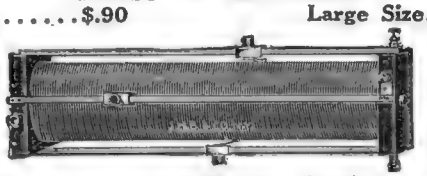

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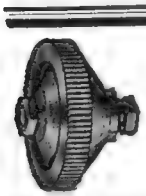

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The New Radio Corporation

By C. D. WAGONER

(*Continued from page* 54)

tions at one time, even if the wave lengths are the same, and it is the plan of the new company to utilize this feature in order to multiply the number of radio stations that may be operated simultaneously.

Mr. Alexanderson says of the barrage receiver:

"In the United States navy's tests of the barrage receiver, it was proven that it is possible to carry on simultaneous communication on exactly the same wave length. If this method of communication is carried out consistently in a world system of communication, it may be assumed that transmitting stations operating on the same wave length may be located as follows: One in Europe, one in the Far East, one in South America, one on the east coast of America and one on the west coast. Thus a message sent to one could be received by the other four, while at the same time messages are being exchanged by the other stations. The barrage receiver makes it possible for these messages not to conflict."

In briefly describing his high frequency alternator, Mr. Alexanderson recently said:

"The alternator which has been in use in the New Brunswick station is rated at 200 kilowatts. It is driven by an induction motor at a speed of 2,170 revolutions per minute to produce a wave length of 13,600 meters. The wave length is determined by the speed of the machine. The only part of the apparatus that moves is the solid steel disc, weighing three tons and turning between two laminated armatures. Directly connected to the alternator is the apparatus for controlling the radio frequency energy. This is known as the *magnetic amplifier.*"

It has been the belief of many that the greater the distance to be covered by radio, the higher the antennae must be, and for that reason it was considered that the practical limit for the use of radio would soon be reached. Mr. Alexanderson has also effected a remedy for this.

Instead of antennae reaching a thousand feet into the air, he has devised a means whereby the wires may be spread out over a broader area and fulfill the same purpose. For the new stations of the Corporation it is planned to use several antennae, each of which is four miles long, mounted on towers similar to those used in power transmission lines.

Edward J. Nally, who has devoted his life to communication service and who for several years has been vice-president and general manager of the Marconi Wireless Telegraph Company of America, has been elected president of the new Radio Corporation.

President Nally has outlined the purpose of the new corporation in the following statement:

"The principal aim and purpose of the new organization will be the establishment and maintenance of trans-oceanic and long distance overland communication.

"The corporation has been greatly strengthened thru its connection with the General Electric Company, by reason of which it will have available for its use the valuable wireless apparatus recently developed by that company, the principal device being already widely known as the Alexanderson high frequency alternator.

"Thru agreements made with the Marconi Wireless Telegraph Company, Ltd., of England, new powers and privileges are granted the new organization, extending its scope of activity and providing, among other things, for the formation of a South American Company to be managed by it."

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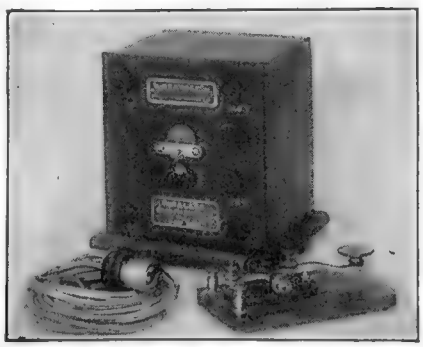

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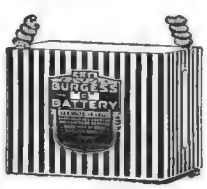

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The Astronomical Spectroscope

By FLOYD L. DARROW

(*Continued from page* 36)

In 1858, Kirchoff and Bunsen discovered the following principles of spectrum analysis: (1) Incandescent solids and liquids and also gases under high pressure give a continuous spectrum, or solid band of color. (2) Highly heated gases under low pressure give a series of bright lines, whose number and position depend upon the elements present. (3) When white light passes thru a gas of lower temperature than its source, this gas will absorb from the white light those colors which it would produce, if viewed by itself in the incandescent state.

With the recognition of these principles it at once became possible to analyze the stars and nebulae of the heavens, for every element in the state of incandescent vapor has its own characteristic bright line spectrum of invariable color and position. But more, this instrument reveals the physical state of stars, nebulae and comets, for a continuous spectrum means an incandescent solid or a gas under great pressure, while a bright line spectrum proves the presence of a light vaporous firemist. This marvelous instrument, too, *discloses the motion of a distant star!* Whenever a star is approaching our solar system its spectrum is shifted from the normal position which it would have if the star were stationary, toward the violet. When the star is moving away from us the spectrum is shifted toward the red. From the amount of the shifting, the velocity may be told with a remarkable degree of accuracy. The alternate shifting of spectra first in one direction, and then the other has led to the discovery of twin stars rotating about a common center of gravity.

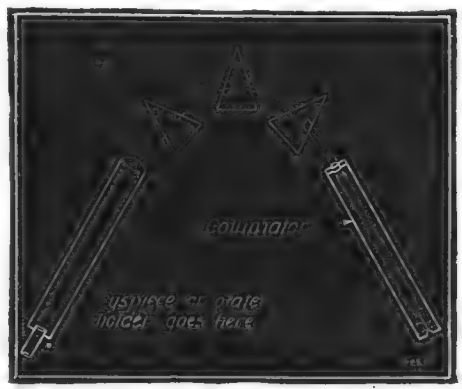

Diagram Showing Arrangement of Prisms of the Spectrograph, Such as Used in Connection with Astronomical Telescopes. To Be Used with a Spectrograph for Photographing the Spectrum, Three Prisms Are Usually Employed, so as to Obtain a Greater Degree of Dispersion, and a Plate Holder Is Substituted for the Eye-Piece.

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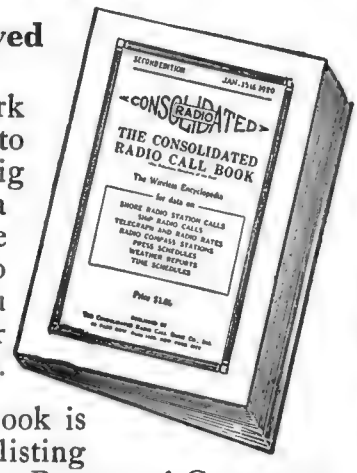

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X-Rays of Unprecedented Hardness

By DR. ALFRED GRADENWITZ

(*Continued from page* 25)

glow cathode even at the highest obtainable vacuum, to be endowed with any desirable speed. Physical investigation on the increase of hardness in terms of the voltage applied was resumed after the adoption of these cathode tubes, and was driven as far as the highest voltages then obtainable, viz., about 170,000 volts, the remarkable result being obtained that from about 145,000 volts on; no further increase in the hardness of X-rays was noted on augmenting the tension. It may be said that in connection with such researches the hardness of X-rays is measured by their *absorption* in well-known metal layers, the intensity of radiation being ascertained, on the one hand, directly as it issues from the tube, and on the other, after traversing a known layer of absorbing metal, mostly aluminum or lead. The figure characteristic of the radiation is termed the *coefficient of absorption.*

In order to ascertain whether the above maximum actually corresponds to the end of the X-ray spectrum or whether the limit is only accidental, due to the conditions of the test, transformers producing even much higher tensions had to be constructed. While the outfits so far in use had proved quite satisfactory for many medical purposes, they would unavoidably break down in the case of continued operation, the risk of puncture increasing far more rapidly than the voltage.

Dr. F. Dessauer, of Frankfort-on-Main, has set himself the task of closely investigating the case and placing the construction of transformers on a radically new basis.

The cause of breakdown was found to be in the fact that there are no insulating materials able in the long run to stand such enormous tensions, unless, in fact, they be given excessive dimensions. If the secondary coil of a 100,000-volt transformer be grounded exactly in the center, thus producing there a tension = zero, there will be a tension at the two terminals of + 50,000 volts and — 50,000 volts respectively. A 200,000-volt transformer would in a similar manner have to stand but 100,000 volts at each terminal.

The solution suggested by Dessauer involves the designing of the transformer in such a way that, while the voltage supplied is as required, insulating material will not have to stand the stress corresponding to this high voltage, this stress being absorbed by special auxiliary transformers, which, having to generate low tension, are quite equal to that task.

The transformer is thus split into two halves, each of which has the ratio required and with each of which an auxiliary transformer is connected in series. These auxiliary transformers need not have any ratio differing from 1, serving as they do exclusively for subdividing and, accordingly, reducing the puncture stress, while the actual transforming is done exclusively by the split main transformer. The high-tension coils being grounded at the juncture in the center, there are at any moment at the two terminals opposite tensions of the same absolute magnitude. The center of each of the secondary half-coils is at a potential one-fourth the transformer tension and is connected with the corresponding primary coil. The primary coils, being insulated from one another and from the ground, the maximum stress is reduced to one-fourth the transformer tension. The following will serve to make this clear:

The task of the primary coil in a transformer, of course, merely consists of converting the electrical energy into a pulsat-

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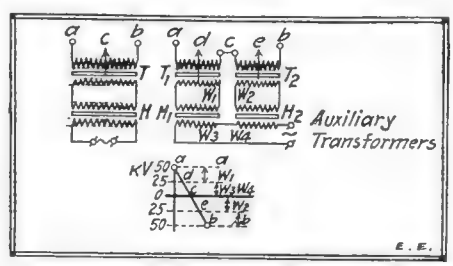
ing field of energy, so that this, in its turn, may in the secondary coil set up a high tension. In the case of ordinary transformers, the flux comes forth from primary coils, which, being directly fed from the mains, are approximately at the potential of the ground. However, it is by no means necessary that the primary coils should be fed directly from the mains, thus being at the potential of the ground. In fact, in the case of Dr. Dessauer's transformer they are no longer fed from the mains, but from another source of current, the potential of which can be controlled at will. Apart from the subdivision of the coils, as above described, the novelty of the transformer lies in the fact that each primary coil receives its current, not from the mains, but from a special source of current, viz., each from the secondary coil of an auxiliary transformer. These auxiliary transformers have no other task but transmitting the energy of the current in the mains to the primary coil of the high-tension transformers, without these being connected to the mains. In fact, the high-tension transformers are only indirectly fed from the mains, which indirect feeding allows the primary coil voltage to be controlled at will, thus reducing the stress.

The same system can, of course, be developed for a greater number of auxiliary transformers, thus reducing even further the stress to be dealt with. Some transformers may, in this case, be dispensed with, the auxiliary transformers constituting, as it were, the corner-pillars of the system, and being given larger dimensions.

The apparatus so far constructed on this system supply an X-ray radiation reduced to half its initial value on passing thru an



Arrangement of Auxiliary X-Ray Transformer for Producing Ultra-High Potentials.

aluminum layer 3 cms. thick. The most efficient apparatus used in actual practise, truth to say, only have a maximum potential of 240,000 volts, the hardest radiation being reduced to half its initial value on passing thru 2 cms. of aluminum. Some machines of the most modern type (producing X-rays with 1.75 cms. aluminum half-value), have for some time past been used with satisfactory results at certain Berlin hospitals. The hardest X-ray radiation above mentioned is only slightly softer than the rays given out from "Radium-C," tho there are no material differences as to the absorption in water and in human flesh.

These extra hard X-rays are, accordingly, to be used as a substitute for Radium rays, it being hoped that the treatment of malignant tumors will be facilitated by their use. There is no objection to constructing machines of up to 400,000 volts; in fact, Dr. Dessauer at present works with an experimental machine of 450,000 volts maximum tension.

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See Page 38

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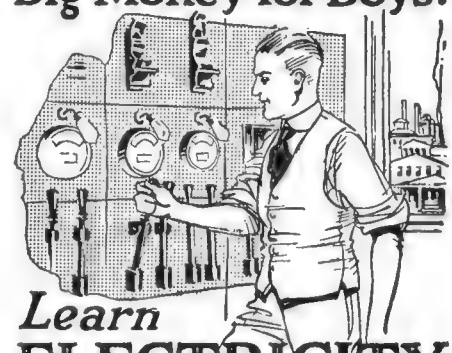

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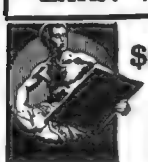

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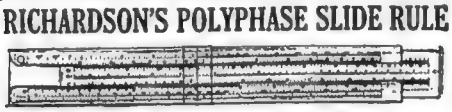

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Largest High Frequency Laboratory

(*Continued from page 37*)

(Note: The voltage required to maintain high frequency corona is much less than that to start it.) Time of exposure, 10 minutes.

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Such a plant would be capable of electrifying many acres of agricultural ground for the purpose of intensifying plant growth, while the cost of operating such a plant is not so unreasonable as it might first seem, considering the tremendous amount of high frequency energy thus rendered available.

An Electromagnetic Galvanometer

By HANS O. STORM

(*Continued from page 50*)

paper should be translucent, so that it may be read from either side, while the spot of light is thrown on the side nearest the instrument. The sun-mirror or other source of light should be placed so that the light strikes the instrument at a slighly downward angle. Then, if the galvanometer is mounted on a level with the operator's eye, his shadow will not be cast on it, and neither will the spot of light reflected by the window, which is fully as bright as that from the mirror, be thrown on the scale to cause confusion.

If desired, the scale can be made very large and drawn upon the opposite wall of the room. The two methods give about equal accuracy. Equal divisions of the scale will approximate equal current increments more closely than any laboriously calculated function of the angle of deflection of the coil.

When calibrating the instrument, it is well to obtain calibration curves showing the sensibilities and deflection constants with varying field currents. It will be found that, with the coils placed as they are, close to the air gap, there will be no definite point of saturation. A more marked saturation point, with greater uniformity of the values lying above it, might be obtained by placing the coils on the sides or back of the magnet, but this would mean a considerable sacrifice of flux thru the air gap.

The positive terminal of the field should be plainly marked, and the current never be reversed, because this would introduce an error due to hysteresis.

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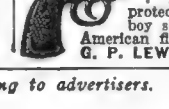

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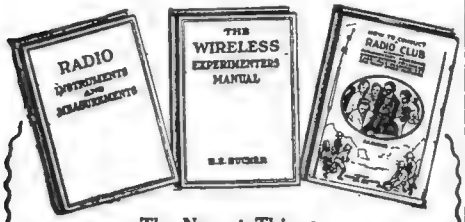

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Radium the Mother of Ions

By HAROLD F. RICHARDS, M.A.

(*Continued from page* 51)

RADIUM DISCHARGES AN INSULATOR.

A simple experiment showing the production of ions by radium can be performed with an ordinary electroscope and a piece of glass or hard rubber. A metal can is attached to the rod which bears the charged gold leaf. If now any piece of non-conducting material, such as dry glass, rubber, or amber, be suspended by a string within this hollow vessel, the movement of the gold leaf will show that the insulator is electrically charged. This is because an insulator *holds* any charge which is may receive by friction or other means, and it is difficult to remove this charge by ordinary agents. If a piece of hard rubber is rubbed with silk, cat fur, leather or, in fact, any dry material, a large electrical charge will be produced upon it. If it is suspended in the electroscope chamber, see figure 3, deflection of the gold leaf will reveal the presence of this charge. But if the rubber is withdrawn, exposed to th radiation from radium or other radioactive substance, and then replaced in the electroscope, the gold leaf does not move. This shows that the radium has removed the electricity of the insulator. If the rubber possest a negative charge, the positive ions produced in the air by the radium were attracted to its surface, and there neutralized its charge.

X-rays or ultra-violet rays will produce the same effect, thus showing that they also ionize the air. The electrified insulator can also be discharged by passing it rapidly thru a flame, as of a candle or gas jet. This is because the combustion of gases in the flame produces ions, just as do the rays of radium.

In a succeeding article I wish to describe a speedometer for these gaseous ions. The apparatus automatically starts and stops the experiment in the space of seven-thousandths of a second, and tells how fast the ions traveled in the meantime. I shall also describe a means by which a *single alpha particle* can be made to register its arrival with pen and ink on paper, very much as a traveler signs the book at a hotel. Science will soon beinducing these infinitesimal particles to walk up to the front door and ring a bell.

A Bench-Lathe from Pipe

By A. NOAH HARRINGTON

(*Continued from page* 48)

shafting, halved out at the ends. The supports for the ends of the shafts are made from pieces of one-quarter inch pipe; FF, are two pieces of one inch pipe, 3½ inches long, fastened to the plate G with machine screws. They are placed on the shafts DD, Fig. 2, and babbitt poured in them around the shafts, first wrapping a piece of thin tissue paper around the shafts, so they will not bind. The plate G, Fig. 2, is 3½ x 3 x ¼, with a one inch hole in the center for the tool holder or post. The tool holder A, is made from a piece of one-half inch pipe. A slot is cut in it to hold the tool and a cap is screwed on the end thru the center of which a hole is bored and threaded for a ⅜ cap screw. It is fastened to the plate A with two lock nuts, one above and one below the plate.

A curved piece of iron, B, is placed under the tool to raise and lower it. The feed screw is shown at H, Fig. 3.

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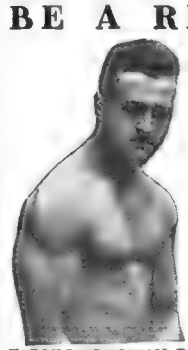

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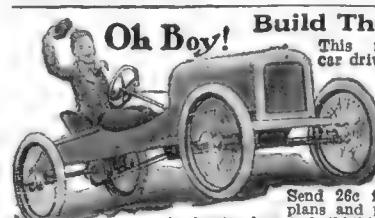

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(*Continued on page* 118)

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